Bulletin of the American Museum of Natural History

Joel Asaph Allen, American Museum of Natural History

BULLETIN

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CENTRAL PARK, NEW YORK CITY.

(77th Street and 8th Avenue.)

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BULLETIN No. 1.

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DECEMBER 23d, 1881.

PRINTED FOR THE MUSEUM.

WM. C. MARTIN, PRINTER, NO. 111 JOHN STREET.

1881.

American Museum of Natural History.

In issuing the present publication, the Officers of the American Museum of Natural History wish to say, that it is their purpose to publish, from time to time, the results of investigations of material in their collection, in the form of Bulletins, of which the present forms the first. It is also their desire to aid students of Natural History and Teachers in our Public Schools in becoming familiar with these subjects, through courses of lectures, given at the Museum, thereby making it a part of the educational system of the City. In pursuance of this object the Board of Education has issued the following circular to the Teachers of the City Schools.

[Signed,] MORRIS K. JESUP,
President.

AM. MUS. OF NAT. HIST.,
New York, Dec. 23d, 1881.

HALL OF THE BOARD OF EDUCATION,
City Superintendent's Office,

November 11th, 1881.

To the PRINCIPALS AND TEACHERS:

In accordance with a resolution of the Board of Education, and upon the recommendation of the Committee on Course of Study and School Books, the undersigned hereby directs the attention of all teachers to the fact that the American Museum of Natural History, possessing a large and costly collection of specimens, illustrative and useful in many departments of science, is now complete, and open to the general public for visitation and inspection. The Trustees of this Museum, through MORRIS K. JESUP, ESQ., Chairman of the Executive Committee, have specially extended an invitation to the teachers and scholars of the public schools, in which invitation the desire is expressed that the Museum may be utilized in the service of public education,

The undersigned therefore suggests and advises that the means of assistance in prosecuting the study of natural science, thus courteously and definitely placed at the disposal of the schools, be rendered as available for the purpose mentioned and made as practically useful as circumstances will permit.

By frequent reference to the existence of the Museum and its many treasures in the department of Natural History, the Principals and

Teachers could and should awaken the interest of the children, and by precept and example, could induce and encourage them to take advantage of the opportunity thus presented. The fact that Teachers from the several schools have traveled great distances in inclement weather to attend a course of Saturday lectures at the Museum, and were amply rewarded for their time and effort, is proof of the Museum's usefulness from an educational point of view; and an announcement of what had been done and is going to be done by teachers, would necessarily be productive of great effect on the minds of the pupils. The elements of Natural Science, taught orally in our Schools, are best presented by those who have an objective acquaintance with that about which they speak and lecture, and the pupil who can pass from the world of books and oral statements into actual contact with the very things of which the books and statements give only imperfect pictures, is in possession of advantages which it would be inexcusable to neglect.

Teachers and Pupils should, therefore, on Saturdays and holidays devote some portion of their time to the Museum and its collection.

Good instruction makes discipline easy. A visit by the meritorious pupils of the class, in company with the teacher, as a reward for satisfactory service during the week or month, would not only increase the pupils' knowledge, but also constitute an effective agency in securing order, interest and attention in the class room, and would thus make the teacher's labor less arduous and exhausting.

The Museum of Natural History is in Seventy-eighth Street, between Eighth and Ninth Avenues. It opens every day, except Sunday, at 9 o'clock A. M., and closes half an hour before sunset.

Very respectfully,

JOHN JASPER,
City Superintendent.

ART. I.—*Description of a new species of Crinoid from the Burlington lime stone, at Burlington, Iowa.* By R. P. WHITFIELD.

In a collection of fossils and minerals lately purchased by the Am. Mus. of Nat. History, from Mr. H. T. Woodman, there is one slab of Burlington Limestone which contains two magnificent examples of a new species of *Poteriocrinus* that is so much more beautiful than any previously described from that prolific locality, that it has been thought desirable to publish the species with illustrations. The specimens, as they lie imbedded in the rock, show, one of them, the anterior and the other the posterior side of the body, while the arms of one of the larger specimens spread out to a length of nearly eight inches, and occupy a breadth on the stone of about three and a half inches. Both specimens preserve a portion of the column, one of which shows the remains of it to a length of about twelve inches below the base of the calyx, without material diminution in size. The following description will, with the accompanying illustrations, serve to give a fair idea of the species.

POTERIOCRINUS JESUPI. n. sp.

Plates 1 and 2. *Figs.* 1.

Body large, the calyx below the arm bases broadly obconical, with the first radial plates and arm bases somewhat protruding, so as to give an irregular pentalobate character to the upper margin of the cup. Column of moderate size, slightly enlarged just at the base of the calyx, composed of quite thin plates, and perforated by a minute circular or slightly pentapetalous canal. Basal plates a little wider than high on the anal side and proportionally lower on the anterior side. Sub-radials wider than high on the anterior side of the body, while those shown on the anal side are as high or higher than wide; both those adjoining the anal area being heptagonal in form, and the others hexagonal. First radial plates half as wide again as high on the anterior and and antero-lateral rays, and as wide again as high on the postero-lateral rays. Second radials about half as high as wide, quadrangular. Third radials

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broadly triangular, the sloping faces supporting the first plates of the arms, except on the anterior ray, where the first bifurcation of the arm takes place on the twelfth plate, those between the first radial and the bifurcating plate gradually decreasing in size upward, and are alternately wider and narrower on their opposite sides. The arms are moderately strong, and round on the back, the surface of the plates smooth and without ornamentation; plates short wedge-shaped, extending entirely across the arm in their lower parts, but often falling a little short at the sides above. The second bifurcation of the anterior ray takes place on the fifteenth plate above the first, on the outer division of each section, and on the eighteenth on the inner division, and of these latter divisions the inner one again divides on the twenty-second plate above the last, and the outer one on the thirty-seventh, on one side of the ray, but varying considerably from this on the other half. This arrangement gives to the anterior ray eight terminal divisions. On the antero-lateral rays, only one of which is perfect enough to count accurately, the first bifurcation above the primary one on the third radial plate takes place on the eleventh plate above, and the second one, on one side, on the sixteenth plate, the inner division again dividing on the twenty-sixth plate above the last bifurcation, above which the arms are simple. The arrangement of the postero-lateral rays differs entirely from that of the others. The first bifurcation is on the third radial plate; the second on the sixth above on the side next to the antero-lateral ray on one of the rays, and on the seventh on all the other divisions. The third bifurcation takes place on the twelfth to the seventeenth plate above the last one, in different divisions of one of the rays, and are even more irregular on the opposite one, one bifurcation being on the twenty-second plate, unless there be a division turned under so as to be unseen. There are three sets of bifurcations on the lateral half of these rays as shown on the most perfect one; above which the arms form eight simple branches; while on the anal half of the ray there are but five branches seen, and not more than six, even if one be hidden. This arrangement gives thirteen (or fourteen ?) branches to each of the postero-lateral rays; and forty-eight terminal branches to the entire crinoid.

[*Dec.* 23*d*,

The tentaculæ as shown on the specimens are traceable to a length, in places, of nearly three-fourths of an inch, rising alternately from opposite sides of the arms, on the longest side of each plate. The first joint is strong and somewhat bulbous at its base. The others are slender, flattened and grooved, and about twice the length of their diameter.

The first anal plate is irregularly pentangular, and rests upon or between the two adjacent sub-radials, and sustains upon one of its faces one side of the right posto-lateral first radial plate. The second anal is smaller, somewhat regularly hexagonal, and rest on the upper truncated end of the left sub-radial and against one face of the first anal on the right side and the lateral face of the left first radial on the other side. The other anal plates are supported upon these in regular vertical ranges, three plainly visible, of constantly decreasing size, and above the third or fourth in height, their surfaces are regularly marked by elevated ridges, crossing from their centres to the adjoining plates, as is common to most upper anal plates or plates of the proboscis of crinoids of this genus. The entire length of the proboscis has not been ascertained, but from the proportions of the parts visible, it is probably of considerable length.

The species most nearly resembling this one among those previously described from the Burlington limestone is *Poteriocrinus swallovi* M. & W. (Geol. Ills., Vol. II, p. 183, Pl. 16, fig. 4, a, and b). It differs so essentially, however, and in so many particulars that a comparison is scarcely possible. The calyx has the same general character and form, but the arrangement of the anal series of plates is entirely different. The arms are also very similar below the first bifurcation, but above this point are entirely unlike, as those are said to be simple above the second bifurcation which takes place on the ninth plate above the first bifurcation on the third radial, in four of the rays; while on the anterior ray the first bifurcation takes place on the sixteenth radial plate, instead of on the eleventh as in this species.

The specific name is given in honor of Morris K. Jesup, Esq., President of the Am. Mus. of Nat. Hist. through whose liberality the collection of which it forms a part was secured to the Museum.

ART. II.—*Remarks on Dictyophyton, and descriptions of new species of allied forms from the Keokuk Beds, at Crawfordsville, Ind.* By R. P. WHITFIELD.

In the Am. Jour. Sci. for July 1881, I published an article on the fossil bodies known as DICTYOPHYTON described and figured in the 16th Report State Cab., New York, stating that they were probably more nearly related to the modern glass sponge *Euplectella* than to marine plants, to which group of organisms they had been referred by the author of the above mentioned genus. At the time the article appeared I had no positive proof of their spongoid character, and only inferred this to be the case from the general form of these bodies; from the similarity of the net-work composing them, and from their power to resist the trituration and maceration in sea water, which they necessarily must have undergone while being imbedded in the sandstones in which they are almost universally found preserved. In speaking of these features the following remarks are made. "If one examine the figures of the various species described, given on Plates 3 to 5 A of the above cited work, it will be seen that these bodies are more or less elongated tubes, straight or curved, cylindrical or angular, nodose or annulated; and that they have been composed of a thin film or pellicle of net-work, made up of longitudinal and horizontal threads which cross each other at right angles, thereby cutting the surface of the fossil into rectangular spaces; often with finer threads between the coarser ones. When the specimens, which are casts or impressions in sandstone, are carefully examined, it is found that these threads are not interwoven with each other like basket work, or like the fibers of cloth, nor do they unite with each other as do vegetable substances; but one set appears to pass on the outside, and the other on the inside of the body. The threads composing the net-work vary in strength, and are in regular sets in both directions, while the entire thickness of the film or substance of the body has been very inconsiderable. In one species, the only one in which the substance filling the space between the cast and the matrix has been observed, it appears to be not more than a twentieth of an inch in thickness, and is ochreous in character.

This peculiar net-like structure does not seem to be that of any known plant, nor does their nodose, annulated, cylindrical or often sharply longitudinally angular form, with nearly perfect corners, indicate a vegetable structure; moreover, it is not a feature likely to be retained in a soft, yielding vegetable body of such extreme delicacy and large size, while drifting about by the action of water, in becoming imbedded in the sand of a sea bottom, but would rather indicate a substance of considerable rigidity and firmness of texture."

"In examining the structure of *Euplectella* it is found to be composed of longitudinal and horizontal bands similar to those above described, with the additional feature of sets of fibers passing in each direction obliquely across or between the longitudinal and horizontal sets, but not interwoven with them ; so that the longitudinal series forms external ribs extending the length of the sponge, and the horizontal series inside ribs or bands, and they appear as if cemented to each other at their crossings. The oblique threads, besides strengthening the structure, cut across the angles of the quadrangular meshes formed by the two principal sets of fibers, and give to them the appearance of circular openings, making the structure much more complicated than in *Dictyophyton*. The addition of oblique fibers in *Euplectella* is the most noticeable difference between the two forms; but if placed horizontally and longitudinally between the primary sets they would produce precisely the structure seen in *Dictyophyton*."

"As yet we have no positive evidence of the nature of the substance which composed the fibers in *Dictyophyton*. The only cases known, so far as I am aware, of the preservation of the substance of the fossil is that mentioned above, where the space between the matrix and the cast is occupied by a ferruginous body, a material which so often replaces siliceous organisms in a fossil state, and specimens of *D. Newberryi* from Richfield, Ohio, on which there occur slight patches of a carbonaceous substance, but not sufficient to warrant the conclusion that it ever formed a part of the structure, even in the opinion of the author of the genus, who supposed these organisms to have been of vegetable origin; especially as they are associated with numerous fragments of terrestrial plants. I am therefore led to the opinion, from their firmness of texture as evinced by the strong markings left in the rock, and the almost perfect retention of their original form that they were of a siliceous nature. Still, in this opinion I may be mistaken, and it must be left for future discovery to determine; but that they were of the nature of sponges and not of plants I feel very confident."

After the above remarks were in the hands of the printer, I had an opportunity of discussing the nature of these organisms with Principal Dawson, of Montreal, during which we examined some fragmentary specimens from the Keokuk beds at Crawfordsville, Indiana, which had but recently come into the possession of the Am. Mus. of Nat. History, on which is retained some of the substance of the net-work. Under a hand glass of moderate power this substance appeared to be made up of cylindrical threads of various sizes, composed of pyrite. With the means then at hand it was not possible to fully determine their character; but from microscopical examinations made more leisurely, the following notes were furnished me by Professor Dawson, and were printed with additional remarks by myself in the August number of the Am. Journal.

Note by Dr. J. W. Dawson *on the Structure of a specimen of Uphantænia, from the Collection of the American Museum of Natural History, New York City.*

To the naked eye the fossil presents rectangular meshes of dark matter on a gray finely arenaceous matrix. The spaces of the net-work are of an average of 6^{mm} in length and 4 or 5 in breadth. The longitudinal bands are about 3^{mm} broad, the transverse bands much narrower. Some of the rectangular interspaces are of the color of the matrix; others wholly or partially stained with dark matter. The meshes are nearly black, but in a bright light show a fibrous texture and metallic lustre due to pyrite.

Viewed as opaque objects under the microscope, the reticulating bands are seen to be fascicles of slender cylindrical rods or spicules, varying much in diameter; some of the largest being in the narrow transverse bands. The spicules may, in a few cases, be seen to be tapering very gently to a point, but usually seem quite cylindrical and smooth. In their present state they appear as solid shining rods of pyrite. The largest spicules are about $\frac{1}{500}$ of an inch in diameter; the smaller scarcely one-fourth of that size. The spicules of the transverse bands cross those of the longitudinal ones without any organic connection. Among the long spicules of the bands can be seen multitudes of very minute and apparently short spicules confusedly disposed, and these abound also in the dark-colored areoles.

On the whole the structures are not identical with those of any plant known to me, and rather resemble those of siliceous sponges of the genus *Euplectella*.

The most puzzling fact in connection with this view is the mineral condition of the spicules now wholly replaced by pyrite. Carbonaceous structures are often replaced in this way, and so are also calcareous shells, especially when they contain much corneous matter, but such changes are not usual with siliceous organisms. If the spicules were originally siliceous, either they must have had large internal cavities which have been filled with pyrite, or the original material must have been wholly dissolved out and its place occupied with pyrite. It is to be observed, however, that in fossil sponges the siliceous matter has not infrequently been dissolved out, and its space left vacant or filled with other matters. I have specimens of *Astylospongia* from the Niagara formation which have thus been replaced by matter of a ferruginous color; and in a bundle of fibers probably of a sponge allied to a *Hyalonema* from the Upper Llandeilo of Scotland, I find the substance of the spicules entirely gone and the spaces formerly occupied by them empty. It should be added that joints of Crinoid stems and fronds of *Fenestella* occurring in the same specimen with the *Uphantænia* are apparently in their natural calcareous state.

Though I have hitherto regarded this curious organism as a fucoid, I confess that the study of the specimen above referred to inclines me to regard it as more probably a sponge.

I owe the opportunity of examining this very interesting specimen to the kindness of Professor Whitfield.

The establishment of the fact, that spiculæ resembling those of sponges formed the substance of these bodies, proves conclusively that they were not of vegetable origin, and is equally conclusive that they were spongoid, while their general form and net-like structure will certainly place them near the recent genus EUPLECTELLA.

As early as 1842, Mr. T. A. Conrad described one of the principal forms of this group of organisms under the name HYDNOCERAS, apparently under the supposition that it was a cephalopod, allied to the Orthocerata (Jour. Acad. Nat. Sci. Phil., p. 267, pl. 16, fig. 1), and in the Rept. 3d Dist. Geol. Surv. New York, p. 183, 1842, Prof. L. Vanuxem mentions and figures another form under the name *Uphantænia Chemungensis*. So far as I am aware no further notice was taken of them until the publication in the 16th Rept. State Cabinet of New York, where there is an extended notice of them given, and the generic name *Dictyophyton* (*woven plant*) proposed, and a number of new species described and figured. In this article the author refers them to the Vegetable Kingdom, with the remark that "they are algæ of a peculiar form and mode of growth." The name *Hydroceras* being discarded on account of its apparent objectionable signification.

In the Quar. Jour. Geol. Soc. London, 1862, p. 325, Professor Dawson gives a figure of *Hydroceras tuberculosum* Con. and also mentions *Uphantænia Chemungensis* Vanuxem; but at that time considered them as probably marine plants.

In the synopsis of British Palæozoic Fossils, p. 62, Prof. McCoy describes what appears to be a species of *Dictyophyton*, (see pl. 1 D, figs. 7 and 8), under the name *Tetragonis Danbyi* Salter's sp. apparently referring it to the same group with *Receptaculites* as Salter had previously done in manuscript. The genus *Tetragonis* sp. *Murchisoni* was described by Eichwald in the "Urwelt Russlands," p. 81, 1841–43, which I have not been able to consult. But in 1860, in the Lethæa Rossica, p. 430, he describes the same species without figure, but from the description, as well as those of two other species of the genus figure, there is no doubt of the very close resemblance of all of them to Receptaculites. Nevertheless both McCoy—*loc-cit*—and subsequently Salter himself refers the English species, apparently a true *Dictyophyton*, to Eichwald's genus. At a much later date Mr. Salter in his catalogue of Camb. and Sil. fossils in the Cambridge Mus. places *Tetragonis* (figuring *T. Danbyi*) under the head of sponges, but without any remark, which I had not noticed until the present writing.

In 1879 Prof. H. A. Nicholson in the 2d Ed. of his Manual of Palæontology, Vol. 1, p. 128, seems to consider *Tetragonis* as a Foraminifer, at least after discussing the genus *Receptaculites* under that head he says: "In any case the Silurian genera described under the name *Ischadites* and *Tetragonis* are certainly the same as *Receptaculites*." It would therefore seem that the name *Tetragonis* cannot enter into competition with others, in point of priority, as applied to these bodies. Still there are three other names up to the date of Prof. Nicholson's work applied to them : *Hydnoceras*, *Uphantænia* and *Dictyophyton.*

In the same year with Nicholson's Manual, 1879, Mr. C. D. Walcott published in Vol. X of the Trans. Albany Inst., p. 18 Ext., the genus *Cyathophycus* for some similar bodies from the Utica Slate, which even more closely resemble *Euplectella* than those above mentioned, although he at the time considered them as Plants, but has since corrected the reference, see Am. Jour. Sci., Nov., 1881, p. 394. This leaves four American generic names applied to forms of this group which do not appear to me to be more than specifically distinct ; inasmuch as they are all composed of threads or bands crossing each other at right angles, in the same general direction, forming the same kind of net-work in all, leaving the external form or shape to constitute their specific individualities. The two later names applied, viz., *Dictyophyton* and *Cyathophycus*, are both misnomers, if the spongoid nature of the organisms is considered as established, while the two former *Hydnoceras* and *Uphantænia* do not imply any zoological or botanical feature, although the first was given under a false impression. It may therefore be necessary to go back to one of the earlier names proposed.

The forms described by Mr. Walcott under the name *Cyathophycus* are the oldest forms geologically yet known, being from the Utica Slate. The English forms given by McCoy and by Salter are from the Upper Ludlow rocks of England, supposed to represent the higher parts of our Lower Helderberg beds, although they contain many representatives of our Hamilton and other Devonian forms of fossils. So far as yet known no forms have been discovered in American rocks between the Utica Slates and the Chemung, where there are several species. They occur in the Waverly of Ohio and in the sandstone at Burlington, Iowa, and are known in six different species from the Keokuk beds of Crawfordsville, Ind.; so their geological range can be said to be from the Lower Silurian to the Lower Carboniferous. The example on which the spiculæ were first observed, and subsequently examined by Prof. Dawson, is somewhat related to Vanuxem's *Uphantænia* in its broad bands, and was at first supposed to be part of a flat circular frond, being so described in the Am. Jour.

Sci., but on further examination was found to bend over at the sides and to pass into the rock beneath ; and on clearing away the matrix from below was found to be a broadly spreading cup, the opposite side showing obscurely when cleared from rock. A second specimen subsequently procured from Prof. John Collette, State Geologist of Ind., which was evidently of the same species, had a distinctly cylindrical form, so that the form would appear to be somewhat variable. In the August number of the Am. Journal above mentioned, I proposed for it the name *Uphantænia Dawsoni*, which I shall retain, and now give the following description of its character.

Uphantænia Dawsoni,

Plate 4. *Figs.* 1 and 2.

Uphantænia Dawsoni, Whitf., Am. Jour. Sci., August. 1881, p.

General form of body broadly cyathiform above, with probably a cylindrical stem of varying dimensions below. Structure composed of longitudinal and horizontal bands, crossing each other at right angles, leaving rectangular spaces between. The longitudinal bands are of two kinds, one broad, the other narrow, alternating with each other, and varying in size according to the dimensions of the body, often attaining a width of three-sixteenths of an inch, while the intermediate ones seldom exceed one-sixteenth of an inch in width. Horizontal bands narrow and equal. Spaces between the rays rectangular, varying from higher than wide to once and a half as wide as high.

The arrangement of wide and narrow longitudinal bands gives two vertical rows of rectangular spaces between each broad band, and the individual spaces in the two rows alternate with each other in being raised or depressed above or below the general surface of the bands, so that they alternately form a node or depression on the surface as shown on the rock. These spaces are covered by a thin film of the same substance as the bands where perfect, but the depressions are usually filled, and the raised node broken in separating the specimen from the matrix, so that the remains appear like a network of bands with rectangular openings in its substance. The appearance however when the nodes and depressions are preserved is much like what would be presented by a fabric in which there were elastic bands, which when contracted would wrinkle up the intermediate portions.

When the specimens of this species, as well as others from the same locality, are examined under a magnifier, they are seen to be composed of a dark pyritous film, and when more highly enlarged this is easily resolved into innumerable slender, thread-like spiculæ, as mentioned in Prof. Dawson's notes, given above. The threads of the narrow transverse and longitudinal bands are large and stronger than those of the broad bands, but have finer intermediate threads among them. The film coating the interradial spaces is composed of a still finer set of spiculæ than the principal ones in either set of rays or bands; under a strong glass they are seen to be arranged in both a transverse and longitudinal direction on different parts of the area, which arrangement gives them a radiating appearance from the centre of a node. It is possible that this species ought not to be placed under the genus *Uphantænia* on account of its cylindrical or cup shaped form, but as the bands so closely resemble those of the type species and are quite unlike those of *Dictyophyton*, I prefer to leave it under that genus until something further is known in regard to the true form of the type species. So far as I can ascertain, the original specimen does not show any indications of striæ or other marking on the surfaces of the band-like impressions, to indicate the existence of spiculæ or threads, but from its general resemblance to parts of *U. Dawsoni*, here described, I have no doubt whatever of their generic identity.

Among the fossils in the museum from the Keokuk beds of Crawfordsville, Ind., there are remains of three or four other species of these peculiar bodies, and among them the one described below is perhaps the most interesting and instructive, and illucidates, perhaps, more distinctly their true form and relations than any other specimen yet discovered except *D. coronatum*, described below. Its probable cylindrical base, with a convex sieve-like cap surrounded by an expanded frill, will at once call to mind, to those familiar with *Euplectella*, its close resemblance to the upper part of that beautiful form although on a somewhat larger scale.

DICTYOPHYTON CATTILIFORME, N. sp.

Plate 3. Fig. 1.

General form of body that of a short, broad tube or cylinder, which may be slightly expanded downward, and is capped above by a more or less convex cover or dome, from the margin of which at its junction with the cylindrical portion, there extends a broad, more or less undulated, horizontal flange or frill-like rim. The lower or cylindrical part is composed of longitudinal (vertical) ribs or threads, crossed by finer and much more closely arranged horizontal or transverse threads, and is strengthened in the upper part, apparently, by strong undulations or folds extending to near the lower part, where they gradually die out. The dome and rim is composed of a series of radiating threads which extend from the centre to the margin of the frill-like rim on every side, increasing in strength as they approach the outer parts, while their relative distance from each other is partially maintained by the addition of new rays between the original ones. This feature also gives them a somewhat alternately stronger and finer character. The radiating threads are crossed by a system of circular threads in rings, somewhat increasing in distance from each other from the centre outward, those in the frill being most distant.

The central part of the summit or dome is moderately depressed-convex, more abruptly bent downwards at the edges where it forms a junction with the cylindrical portion below, and from which point the frill-like expansion rises; so that the constriction distinctly marks the line of junction, and gives the diameter of the cylindrical stem of the body. The specimen used and of which the figure given is natural size, is somewhat obliquely crushed in the lower part so that the cylindrical portion is flattened and pressed out on one side, making it appear broader than it actually was in life. Its line of bedding in the rock is readily traceable at the opposite end of the specimen, and the rock is fractured along the line of constriction between the dome and frill, showing its existence all round. The summit was embedded horizontally in the rock and is but little compressed. The present form is somewhat regularly oval, the dome having a diameter of nearly four and one-half by almost six inches, while the rim varies from one and one-fourth to almost two inches in width.

[*Dec. 23d,*

The disc is imperfect on one side, but the portion below where the cylindrical part is shown beneath in the figure is preserved, and was purposely removed to show the connexion of the lower part with the discoid top of the organism. The dotted line, *aa*, shows the margin of the rim when the removed parts are in place. No spiculæ are preserved on this specimen, but the rock is colored by the decomposition of pyrites, and the surface in many parts, especially near the upper end of the cylindrical portion, is densely covered by small round grains of gypsum, which were at first thought to be part of the organism until they were found common on many other fossils from the same locality, and are probably the result of the action of the sulphur from the pyrite on the lime of the rock. Another species which is described below under the specific name "*cylindricum*," preserves the spiculæ in the most beautiful and distinct manner.

DICTYOPHYTON CYLINDRICUM. N. sp.

Plate 4. *Fig.* 3.

Body so far as known cylindrical, and destitute of any distinct markings or ornamentation, so far as can be seen by the unaided eye ; but apparently formed of a thin compact film. But under a magnifier it is seen to be composed of longitudinal and transverse fibers or threads, which give a finely reticulate texture. When more highly magnified the substance of the threads is seen to be composed of bundles of cylindrical spiculæ of various sizes and of great length. Those forming the longitudinal threads are strong, with finer intermediate threads, and pass mostly along the outer surface, while the transverse portions are very fine and seem mostly to be on the inner surface of the substance.

The specimen of this species used is a flattened cylinder about three inches in length by more than two inches in width as it lies on the rock, but is imperfect at each end and is apparently a fragment only. It is to the unaided eye destitute of markings, but presents a compact leathery surface. The spiculæ are very large and very numerous, and are quite direct in their course along the tube or transverse to it, crossing each other at right angles ; but after careful examination I do not find any of them interwoven like the threads of a piece of cloth. The one fiber seems to pass over the other at one place, continuing to do so as far as it or its imprint can be traced on the specimen.

Beyond the three species here described there are fragments of three others from the same locality in the Museum collection, but as they are all so imperfect as not to give any definite indication of their complete form, I shall not describe them at the present time, the last named one, *D. cylindricum*, being used on account of its very distinct and perfectly shown spiculæ. Representatives of the species are in the museum collection.

ART. III.—*Observations on the purposes of the embryonic sheaths of Endoceras, and their bearing on the origin of the siphon in the Orthocerata.* By R. P. WHITFIELD.

The genus ENDOCERAS was proposed in 1847 for a group of fossil Cephalopods, belonging to the ORTHOCERATIDÆ, which presents the anomalous feature of a series of invaginated, conical sheaths, occupying the cavity of the siphon. When the genus was proposed, these sheaths were supposed by its author, to be of the nature of embryonic sheaths designed for the retention and protection of the young shells while they were yet within the body of the parent. The existence of such a feature in an animal, of course, presupposes that animal to be viviparous in character, and the announcement of such a feature existing in a cephalopod was entirely unexpected and novel; and consequently attracted considerable attention among naturalists of the day, especially of those studying Palæontology; and there is perhaps no one feature of the fossil Cephalopoda which has given origin to so much discussion, or about which so much has been written as the supposed purposes of these so called embryonic sheaths of the ENDOCERAS. Most of the Palæontologists of note in Europe, writing within several years of its announcement, expressed their opinions of their nature; and most of thcm adversely to their embryonic functions. Notwithstanding these discussions, and their opposition to their embryonic purposes, no one, so far as I have been able to ascertain, has assigned to them any definite functions, or has attempted to show why they were formed. While working over the typical collection of this group of shells originally used by the author of the genus in his studies, and now arranged in the collection of the Am. Mus. of Nat. History, in New York City, the peculiarities of some of these sheaths were studied, and I came to the conclusion that they must have had a purpose in the economy of the animal other than that of the ordinary siphon of the *Orthoceras* and its allied forms; especially as the siphon in these very species is otherwise perfect without them. For the purpose of ascertaining this function I made a critical study of all the forms of this group of shells to which I could get access, and even made a journey to localities where they were common that I might study them in the rocks.

One of the most noticeable characters observed in all species presenting this feature of duplicate sheaths, is their large siphons, commonly one-third as great as the diameter of the shell itself. Another feature is that the duplicate sheaths are seldom found in examples where the outer tube is less than one inch in diameter, and not often in shells of less than one and one-half inches in diameter. Another constant feature is that the young shells of any of these species, even those found within the sheath, and originally supposed to be the offspring of that individual, have very small siphons; even smaller than those of most small specimens of the ordinary *Orthoceras*. These facts alone show conclusively that these duplicate siphons or "embryo sheaths" are a feature consequent on the large siphon; and the question naturally follows, what is there about the large siphon of *Endoceras* that requires these duplicate sheaths; and are they always found, and at regular intervals in those species?

In following out these inquiries, I find them not only all species with large siphons, but that all those having these duplicate sheaths, are forms which increase but very slowly in diameter in proportion to their increase in length, and that most of them occasionally attain a very large size. This as a matter of course implies great length in adult specimens, if entire; and consequently an unwieldly object to be controlled by a comparatively small animal situated entirely at one end of the tube. Another feature is that the shells are usually very thin in substance. Now an animal having a shell of great size and length, and comparatively thin in texture, if an inhabitant of shallow water, would be particularly liable to accident from breakage of the shell by the beating action of the waves; and if an inhabitant of deep seas, to rapid erosion of the shell by the action of carbonic acid in the sea water; so that in either case the shell would be liable to injury to such an extent as to afford free access to water and other extraneous substances to the lower part of the wide siphonal tube, and by it, to the lower part of the body of the animal, or even to the chamber of habitation. In proof of this frequent injury in the case of *Endoceras*, we find them nearly always in a fragmentary condition, the earlier parts having been broken away or otherwise destroyed, even those having a diameter of six or eight inches being seldom more than two to four feet in length, although larger specimens are occasionally found, and the older parts of the shell are even then usually much broken and rotted, and the lower end of the siphon open. So it would appear that for the purpose of protection from these accidents, even if the shell was not in some cases purposely broken, it would be necessary that there should be some provision for closing these avenues, and guarding against these attacks in the rear.

If we examine these conical sheaths or tubes, and ascertain their relations to the siphonal tubes, and to the outer chamber or chamber of habitation, we will find that the passage-way from without through the siphonal tube to the part occupied by the animal above it, is most effectually closed by any one of these sheaths. It is natural, therefore, to infer that they have been constructed for the purposes of self protection. They also show conclusively that the body of the animal extended downward to a considerable distance into the siphonal cavity, and in order to construct one of these sheaths, the part of the mantle of the animal, and that part of the body which lined the upper part of the siphon, which was also the part destined to secrete the shell, would be contracted so as to separate from the siphon and form a long, finger-like projection, hanging loosely in its cavity, (see fig.

1, *d*) ; while the surface of it would soon become coated by the newly secreted shell, having the form of the projection on the surface of which it was moulded ; and when sufficiently thickened would effectually cut off all communication from below and completely repair the damage. After the completion of one of these sheaths at the stage of any particular septum, the growth of the shell and the formation of additional septa go on regularly, and the siphonal space is regularly increased above, leaving it open to the sheath below until occasion requires the formation of another sheath. These sheaths were not only formed in case of accidents already having taken place, but were probably often formed to guard against future troubles; consequently we sometimes find them crowded together so as to leave not more than an inch or so between them, and the intervening space filled with coarsely crystalline calc-spar ; showing that the one below had not been injured so as to admit the access of foreign matter, which is always sure to be the case where injury has occurred to the individual sheath below the cavity so filled.

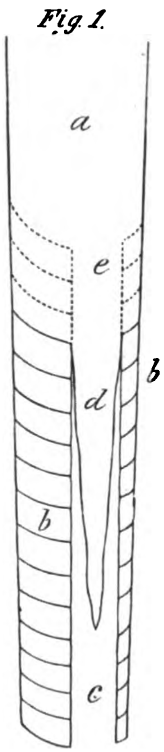


Fig. 1. Ideal section of Endoceras. *a*, outer chamber or chamber of habitation ; *b*, *b*. chamber formed by the ordinary septa ; *c*, siphonal cavity ; *d*, the so called "embryo tube" ; *e*, dotted line, representing the next septa to be formed and the continuation of the siphon walls. The lettering on the other figures correspond to the same parts as on this.

In looking over the observations of M. J. Barrande, of Bohemia, upon this group of shells, in the light of whose writings concerning them those of all others fall entirely into the shade, I find no reference whatever to a probable purpose for which these sheaths were formed, or their connection with the repair of damages to the older parts of the shell. On the contrary he appears to have considered them as a part of the siphon itself, or rather as a second septum intended to divide the siphonal tube into chambers like those of the outer tube, and to have been formed at somewhat regular intervals ; which is by no means the case, at least not in the American species, for I find no regularity whatever in the distances at which they occur even in the same individual. They often occur quite close together, sometimes three or four of them being ensheathed within each other, and others again will have from ten to twenty inches between them ; and I have seen examples of the shell from two to four feet long without a trace of a sheath.*

M. Barrande supposes that when formed at irregular and distant intervals, the prolongation of the animal which occupies the sheath has been suddenly elevated or lifted up from its former position and held suspended in the cavity of the shell until a new shell or sheath was secreted on its surface. But he assigns no reasons for such an act. In speaking of this feature in the Bul. Geol. Soc. of France, 1855, p. 173, he says : "in fact, to account for the presence of sundry tubes or sheaths irregularly envaginated in the siphon of the *Endoceras*, it suffices to assume that at certain periods the animal raised itself, more or less at a time, instead of advancing in a slow and continuous fashion."† Now we have no reason for supposing that the animal of *Endoceras* could elevate the siphonal extension of its body to any appreciable extent without also elevating the rest of the body to a nearly equal distance at the same time ; in which case we should find the septa of the outer tube placed at irregular distances corresponding to those of the sheaths. But this is never the case ; nor do we ever find any more irregularity among the septa of this form than in the ordinary forms of *Orthoceras* where there are never any sheaths formed. There is, however, another group which has been universally confounded with the *Endoceras*, but which is very distinct as far as the origin and formation of the sheaths is

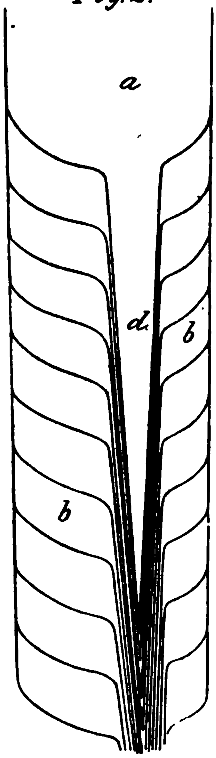
* This mode of repairing injuries is not analogous to that seen in *Orthoceras truncatum* and other forms of Cephalopods, as described by M. Barrande in the Bul. Geol. Soc. France, 1859 and 1860, p. 573 ; where the entire extremity of the shell is closed over by a deposit of shelly matter, secreted by some appropriate organ from the exterior, but takes place from within entirely, and is performed by the posterior prolongation of the mantle or body of the animal occupying the siphon.

† " En effet, pour se rendre compte de la présence de divers tubes ou gaînes irrégulièrement envaginés dans le siphon des *Endoceras*, il suffit de concevoir qu' á certaines époques l' animal s' élevait rapidement d' une quantité plus on moins grande, au lien de progresser d' une manière lente et continue."

concerned, and in which the sheaths are regularly formed one within the other, and in close proximity to each other, as stated by Barrande. This is the form which is properly known and characterized as the section *Vaginata* by Barrande and others, and is typified by *Orthoceras duplex* and *O. vaginatum* in Europe and by *Endoceras multitubulatum* in America.

In this form, the true *vaginata*, the siphonal space, for there is no true siphonal tube, is occupied by a succession of invaginated sheaths or tubes, closely formed within each other, so as to be in absolute contact at the upper end, and are usually as numerous as the septa of the outer tube of which they form a part, while the intervening spaces in the lower part are filled up by a peculiar deposit, known as the "*organic deposit*"—("*dépôt organique*") of Barrande. When these sheaths are closely examined, especially in a longitudinal section, each sheath of the siphonal space is traceable to a definite septum, and is seen to be a continuation of it, but from their slight increase in size are in close contact in the upper part where united to the septum. With a glass, however, they are seen to be composed of separate layers, corresponding to the periods of elevation ; Just as can be seen in some cases in the tubes of *Endoceras* where the sheaths are near each other.

Fig. 2.



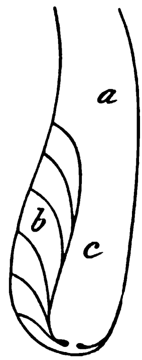
Ideal section of *Endoceras multitubulatum*.—HALL.

These sheaths in the true *Vaginata* actually divide the siphonal space into separate chambers, while the coalescence of their upper ends appear to form a continuous tube resembling the siphonal tube of the *Endoceras*, though the spaces below are invariably filled up solid by the "*organic deposit.*" So far as I have been able to determine from the specimens I have examined, many of which have been in the field, and not capable of separation from the matrix except in fragments, the sheaths are not perforated at the lower end, and do not allow of any kind of communication between the chambers of the siphonal space, any more than do the septa of the outer tube of an *Orthoceras* between the several chambers where the siphon is continuous. From this it would appear that the entire shell of the true *Vaginate Orthoceras* is actually divided into separate and distinct transverse sections, without any means of intercommunication between them; while in the *Endoceras* there is a true siphonal tube which is continuous, but which may be partitioned off at irregular intervals at the will of the animal, by a conical tube similar to those in the true *Vaginata*.

If this view is correct, and the facts seen are properly interpreted, *Endoceras* would seem to have made a distinct step in advance in the development of the siphon, beyond such forms as the true *Vaginata*, where the siphonal space is divided into distinct chambers, toward the open siphon of the normal *Orthoceras*.

M. Barrande has stated in his observation in the Bull. loc. cit. that *Ascoceras* was probably the prototype of the entire *Nautilidæ*; that it contains all the elements of the true Nautilus but in a simple and more undeveloped form. This genus, which has a sack-like form, with imperfect septa extending only partially across the cavity of the tube, leaving a vacant space on one side the entire length of the tube, which he considered as equivalent to the siphon of the ordinary *Orthoceras*, is unquestionably of an extremely simple type. It seems to me however that it is more properly an aberrant or imperfectly developed branch or offshoot of the ordinary *Orthoceras* than a prototype; and consequently appears at a period in geological history in which the greatest diversity among these simple chambered forms of Cephalopods had been attained. Its author even questions the correctness of a reference of the genus by Prof. F. Rœmer to a lower horizon than that in which he has obtained its great specific development. In the true *Vaginata* it seems to me we have a much nearer approach to the probable original form of the chambered

Fig. 3.

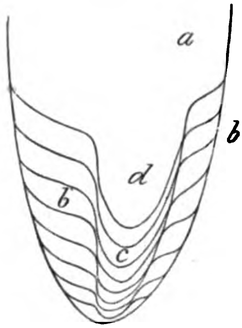


Ideal section of ASCOCERAS.

shell; that in which there was only a simple partition across the tube, no siphon and no communication between the several chambers.

In the genus *Piloceras* of Salter we probably have the nearest approach to this simple form yet known. It consists of a broad conical shell, with a broad conical siphonal tube, divided into chambers by a series of inverted, envaginated cones, which are simple continuations of the ordinary septa; but which are just deep enough to have their necks connect so as to present the appearance of the siphon being continuous, but without means of communication between the several chambers into which they divide the siphonal space. In other words it may be described as a broadly conical shell with the simple septa pressed downward on one side of the centre so as to cause the depression of one septum to enter that of the one below. In this way the siphonal space seems to be limited by a continuous wall and presents the same appearance that do shells of the true vaginate *Orthoceras*, as *O. duplex*, &c.; and differ in reality only in the shell and siphonal depression being wide and spreading, instead of narrow and cylindrical as are those of that group.

Fig. 4.



Ideal section of PILOCERAS.

These forms having wide spreading shells with similarly formed siphonal tubes, are found only in the lower geological formations, and as we ascend into the higher formations the siphonal tubes become gradually narrowed until in the Upper Silurian and Devonian they reach nearly a minimum size. These facts alone would seem to indicate that the development of the siphon had resulted in this direction, and the most likely course would be from a simple septum (not yet found) through the broad open depression existing in *Piloceras* and *Cyrtocerina* to the narrower envaginated siphonal tubes of *Orthoceras duplex* and its congeners without communication between their chambers through the tube, to the open siphon of *Endoceras* with its occasional conical partitions used only in case of accident to the somewhat narrower but similarly formed tubes of *Cameroceras*, where the conical tubes are never formed, on to the narrow unobstructed siphons of the ordinary *Orthoceras*, where it is so narrow as to leave no appreciably open avenue for the entrance of extraneous substances in case of accident. While during the progress toward the narrow plain siphons, there have been developed all the numerous forms of obstructed siphons so abundant and various in the Trenton and Niagara formations.

[*Dec.* 23*d*, 1881.]

ARTICLE IV.—*Description of Lymnæa (Bulimnæa) megasoma*, Say, *with an account of changes produced in the offspring by unfavorable conditions of life.* By R. P. WHITFIELD.

During the meeting of the Am. Assoc. for the Adv. of Science, held at Burlington, Vt., in 1867, Mr. Chittenden, of New York, exhibited living specimens of *Lymnæa megasoma*, Say, procured near that city, at a locality formerly well known to naturalists, but at which, for many years previous to that time, the species was supposed to have become extinct. The individuals exhibited were obtained from the stream which formerly supplied the pond where they had previously been found.

After the adjournment of the meeting the shells were distributed among members of the Society, from one of whom, Prof. James Hall, of Albany, N. Y., I obtained three individuals, two adults and one partially grown. One of the adults I succeeded in preserving alive until the following summer, the others died soon after I received them.

The species has been recognized at only a very few localities. Say's types were collected by Dr. Bigsby at Bois-blanc Lake, north of Lake Superior. Prof. Hall also collected it near Lake Superior. W. G. Binney cites also W. Stimpson as having collected it at that locality, and it was well known from Burlington, Vt., from a small pond between the town and the Lake shore, (long since filled up,) but I believe has never been recognized in the waters of the Lake itself. I have seen the shells in collections marked "Michigan," and "Near Montreal," but I think these latter localities have not been authenticated. In Long's Expedition, p. 263, 1824, Mr. Say gives the following description of the shell: "Large, dilated suboval; spire short, rapidly diminishing, acute; whorls about five, rounded, obtusely wrinkled across; body whorl large, the wrinkles very obvious, suture deeply impressed; aperture subovate, much longer than the spire, within chestnut-brown; columella white." * * * "The color is brownish, sometimes lineated across the body whorl with dull greenish and pale ochraceous;" The color of the interior of the shell is chestnut-brown to purplish-brown. Say gives the length as more than one and six-tenths of an inch, but the Vermont shells often attain a length of two inches. In Prof. S. S. Haldeman's monograph (page 6, Genus Lymnæa) he proposes the generic name Bulimnæa for this shell.

There is considerable difference in the form and texture of the shell between the Western specimens and those from Vermont; the latter being more ventricose, especially in the last volution, and the shell less regular in form and in the growth lines and texture of the suface; neither is it so bright in color. In comparing nearly three hundred individuals from the Vermont locality with about fifty individuals from the Lake Superior region, some years ago, these differences were seen to be very marked. As I have not been able to find any description of the animal of this species, I give the following, which was taken from that of the adult Vermont specimen above referred to, the shell of which is one inch and seven-eighths long.

Animal blackish, the head and tentacles marked with small yellow spots which give a brownish color on close inspection; and when the animal is in motion the surface has the appearance of being covered with a superficial bloom of a russet color. Foot blackish grey, lighter beneath; mantle bluish grey, slightly tinged with yellow towards the posterior angle of the shell aperture. Head broadly semicircular, spreading below, obtusely angular at the posterior lateral margins and slightly emarginate in front. Foot disc broadly rounded in front and tapering behind to an obtusely rounded point; about five-eighths of an inch wide near the anterior end, and together with the head measures about one inch and five-eighths in length when the animal is in motion. Tentacles broad and thin, more than half an inch long, slightly curving inward and irregularly tapering to an obtuse point. Eye spots small, situated at the inner base of the tentacles; yellow in color with a black centre. Respiratory orifice of the pulmonary sac situated a little less than half an inch from the posterior angle of the shell aperture, and when fully dilated, as in the act of receiving air, is about one-fourth of an inch in its greatest diameter, and regularly oval in outline. The portion of the pulmonary sac near the respiratory orifice is very flexible, and is often protruded fully half an inch beyond the margin of the shell in the form of a long, slender, siphonal process, in the efforts of the animal to reach the surface of the water for the purposes of respiration.

In examining the internal features of the animal there are a few prominent points of difference noticeable, as compared with the internal parts of any of the species of Lymnæa which I have been able to examine. These were, however, all of small or medium sized forms, *L. elodes* being as large as any I could obtain. I shall mention only a few of these features, without attempting an elaborate description of their entire characters. In tracing the features of the alimentary canal the oral aperture is found to be surrounded by five plates. The jaw, or horizontal plate is curved and armed with a small beak or central projection. The lateral plates are two on each side in adult individuals, instead of one only as in most Lymnæidæ. The upper one is very elongate-triangular, widest above, slightly truncated at the lower end, to which is articulated a second very much smaller triangular piece, pointed at the lower end. The pharynx or buccal mass is very large, and the radula or lingual membrane quadrangular in form when separated and spread out, with the antero lateral angles slightly truncated from wearing. It is about three-sixteenths of an inch long and about one-tenth wide. The denticles are arranged in about one hundred and thirty transverse rows, of one hundred and one in each row. They are of three kinds on each side of the central one, and are arranged in the following order: 10–25–15–1–15–25–10. The central series consists of a simple point or granule. The next fifteen on each side are similar to each other, except a general increase in obliquity from the centre outward, being short, broad and tricuspid, or occasionally having a fourth point on the sides of the central one, which is the longest. The first series of uncinæ, twenty-five in number, are long, oblique and narrowed above, forming a neck and again expanding toward the end; the serrated edge is oblique to the axis, and divided into three, four, or occasionally five serrations. The second kind of uncinæ, ten in number on each side, are small and slender, tricuspid, irregularly curved and loosely arranged. All the denticles become narrower and more oblique to the axis of the membrane as they recede from the central line, and their serrated faces directed more and more outward.

The salivary gland is situated at a very short distance below the pharynx, and surrounds the œsophagus. It is of a bright lemon yellow color and forms a rather conspicuous feature.

The most noticeable feature in the anatomy of the soft parts, is an organ which is situated immediately in front of the stomach, in connection with the dilatation of the œsophagus usually referred to as the "*crop.*" In the ordinary forms of the Lymnæidæ this crop forms a fleshy expansion of the canal, but is of a soft texture and similar in character and color to the adjoining parts, but in this species there is a distinct organ presenting all the features of a true gizzard. This body is of about the size of a small pea, of a bright salmon color, and composed of two concavo-convex parts, somewhat elliptical in outline, placed on one side of the dilated portion of the œsophagus so as to half surround it. They are attached at their extremities by firm ligaments of a silvery white lustre, very similar in appearance to those on the outside of the gizzard of the commom barn-yard fowl. The interior of the gizzard is hard and firm, and somewhat wrinkled transversely. There is usually more or less sand found in the interior; that taken from the original Vermont specimen, when cleansed from foreign matter, was sufficient to have made a pellet one-twelfth of an inch in diameter. The true stomach is quite large and curved, opening from the lower side of the gizzard and gradually contracting behind to the diameter of the intestine.

The other organs do not differ essentially in form or position from the corresponding parts of other Lymnæidæ. In size and distinctness however, they are remarkable. The hepatic gland is very large, and with the hermaphrodite gland, which is imbedded in its substance, occupies all the upper part of the shell. The hermaphrodite gland exists as several small tufts of a deep flesh-color; the extremities of the tufts or bunches projecting to the surface of the hepatic gland are readily discernable from its dark greenish brown substance.

Some very curious changes were produced in the offspring of this species by the confinement and other unnatural conditions under which they were kept, during several years, in aquaria of limited size. The adult individual of the three original ones obtained, I succeeded in preserving alive until the summer following. On the second of February, 1868, about seven months after I received it, I observed a nidamentum filled with eggs adhering to the plants in the aquarium. I had examined the vessel the previous evening, and as I had not observed it at that time I inferred it had been deposited within the preceding eighteen hours. The nidamentum measured one and one-quarter inches in length and about one quarter of an inch in width, reniform in outline, and contained seventy-two perfect ova, and a few without germinal spots. The ova were about one-twenty-fourth of an inch in their longest diameter, and of a broad oval form. A rather curious transformation was noticed to be taking place in the form of the germinal vesicle. In some of the ova it was already spherical, in several it was composed of two flattened spheres in close contact, as is described to be the case in the ova of Anodonta (Balfour Treat., Comp. Emb., Vol. 1, p. 31.), and in several it was seen to have the form of two discs united by a curved ligature of similar substance. The following day the germinal vesicles were each composed of a single spherical body. On the fourth day after their deposition, motion was first observed of the germinal vesicle. At this time a second nidamentum was observed, filled with ova. In the germinal spots of these the same changes were observed as in the others, and as it was detected at an earlier period, some of the spots consisted of a spiral thread, loosely coiled, but with the ends more closely coiled, forming discs, which gradually increased in size and approached each other as the thread between shortened, until they assumed the form of depressed spheres, and finally became united into a single spherical body.

With the instruments then at my command I was not able to trace all the changes of the embryos, but on the fifth day after their deposition I noticed a rapid revolving motion in those of the first nidamentum, and for several days they continued to increase in size and were very active, but on the fourteenth and fifteenth days they became inactive and soon died.

In the ova of the second nidamentum the same changes were observed as in those of the first, and on the twelfth day the form of the animal was distinctly visible, the shell having a little more than one volution ; the foot, head and eyes were clearly distinguishable, and the position of the heart distinctly observed. On the fifteenth day the pulsations of the heart were counted and found to be forty-five in thirty seconds. On the fourteenth and fifteenth days the tentacles were observable with a low power glass, and the ocular lobes very prominent. The embryos escaped from the ova and nidamentum on the twentieth day, and were observed on the surface of the water obtaining air in the ordinary manner of the adult animal, and apparently feeding upon the slimy coating of the plants and glass.

In the spring of 1868 I placed several of the young shells when about half an inch in length, in various ponds and small streams in the vicinity of Albany, N. Y., where the conditions seemed favorable for their preservation, and retained others in a small aquarium at home.

I had been somewhat surprised to find that the ova deposited by the Vermont shell were fertile, as the animals of this group of molluscs are said to be diœcious, requiring the congress of two individuals for fertility. The Vermont shell having been kept solitary from September 1867 until February 1868, the time when it deposited the nidamentæ, would seem to prove that this is not necessarily the case, unless, as Capt. W. H. Dall suggests, it had been in copula before I received it, and the semen had been retained in the *receptacula seminis* during the entire period without loss of its properties. From the young shells placed in various localities in the vicinity of Albany I obtained no results, except in one instance. In this case I found about thirty individuals two-thirds grown in June 1869, and large individuals in September of the same year, also a nidamentum nearly three inches in length filled with ova, lying loose upon the sandy bottom of the pond. I also found fully grown individuals, of large size, in 1870. From my observations upon these specimens I inferred that hybernation began early in September and ended in the spring, during the middle or latter part of May. All the individuals obtained from this pond have the exact form, size and characters of the original stock as obtained from their native locality in Vermont. But the changes that were produced in those kept in aquaria were so remarkable that I have thought them worthy of being recorded.

The specimens retained in aquaria were the larger and more thrifty specimens from the second nidamentum deposited by the Vermont shell, being of the same brood as those transplanted to the aforementioned pond. They were carefully treated and observed almost daily during the entire time required for the observations recorded below. These young shells had acquired a little more than half the size of the parent shell in February of the following year (1869), being then nearly a year old. During this month several of them deposited nidamenta containing fertile ova. Those first observed were carefully separated from all others and cared for. A second nidamentum was deposited by some of these same specimens during the early part of the summer. Those of the winter brood deposited nidamenta in the spring of 1870. From one of these last, when grown and about eleven months old, being the fourth generation, or the third removed from the parent shell, the figure 10, Plate 1, was made.

Each generation of those kept in confinement differs in the form of the shell from the original type; the first only in size; the second in size and very slightly also in the degree of ventricosity, especially of the earlier volutions; but the third very markedly in the slender form of the earlier volutions; and in the narrow aperture as well as in the dimished size. This was not only the case in a few individuals, but in all of the brood, eight of which I succeeded in preserving until they were about seventeen months old. This peculiar change in the form of the spire interested me greatly, and I became anxious to ascertain its cause.

The previous generations had invariably produced nidamentæ during February or March; but the individuals of this slender spired brood failed to produce any during the spring or early summer months. When in the early summer one of the specimens died I examined the soft parts of the animal and failed to find any trace of the hermaphrodite gland, which should be imbedded in the substance of the hepatic gland in the apical volutions of the spire. I had made a constant practice of examining the soft parts of the animals, using Dr. Joseph Leidy's excellent memoir, published in Binney's Terrestrial Mollusca as a guide, and had become familiar with the different organs. After failing to trace this organ in the dead individual, I tried a living specimen with equally poor success; even when attempting to trace the organs by following up the hermaphrodite duct from below, it was lost in the thinnest film of membrane before reaching the seat of the gland itself. Although I made the attempt on several specimens of the brood, I obtained only the same result in each case.

Late in June of that year (1871), I visited the pond previously mentioned and procured a single adult individual, which was placed in an aquarium containing a number of the slender spired individuals. On the fourth day after I found it paired with one of them, and carefully removed both to another vessel, together with the plants among which they rested. That evening I found that each individual had deposited a nidamentum containing ova; that of the small individual being attached to the shell of the other, and that of the large introduced specimen fastened to the plants in the water, the animals being still paired. The nidamentum of the shell with slender spire was removed to a separate vessel, and in due time the young individuals escaped from the eggs, and were preserved until they attained a length of more than an eighth of an inch, when they were destroyed by an accident to the aquarium during my absence from home. None of the other individuals of this brood (*i. e.*, those with slender spires) deposited fertile ova, although several of them formed nidamenta containing ova, but which were entirely destitute of germinal vesicles.

From the foregoing facts it would appear that the slender spire of the shells of the fourth generation might be the result of the atrophy of a portion of the organs usually occupying that part of the shell, namely the hermaphrodite gland; and that this change in the anatomical features of the individuals of this generation was in some way the result of, or dependent upon the changed conditions under which they had existed during their confinement in the aquaria; resulting in the production of a monœcious animal from a diœcious one of the most perfect kind. Also in changing the specific characters, as far as the form of the shell can be considered, to such an extent that when shown to a good working conchologist (Dr. James Lewis) he gave it as his opinion that they could have no specific relations to each other.

That these changes were the result of the adverse circumstances under which they existed is distinctly proved by the fact that those of the second generation which were reared in the pond near Albany under very favorable conditions not only retained their diœcious character, but also the same specific features as those of the original locality, and in many instances attained an unusually large size.

One peculiar feature attending the changes produced in these animals, is that all those of the fourth generation which attained maturity were apparently of the same sex, which would as a matter of course, without the introduction of individuals of more perfect character, have resulted in the extinction of the species. But had the experiment been conducted upon a large number of individuals both sexes might have been produced, but in different individuals, which might have resulted in the establishment of a monœcious species. In discussing this subject Mr. Dall suggests that perhaps the changes which took place in the animals and shells might have been due to *close breeding*, resulting in sterility in the later generations; but in this connection states that in plants, under such conditions, the male organs are the ones usually retained, probably owing to their requiring less nutriment. In this case, however, the female organs retained their vitality in all the individuals of the fourth generation, and no males appeared to be developed.

NOTE.—The series of shells representing the changes and modifications above described, are now in the collection of the Museum.

Since the above article has been in type I have received from Dr. L. Johnson, of New York, a specimen of *Lymnæa stagnalis*, from near Sodus Bay, Lake Ontario, which on examination shows a gizzard-like body closely resembling that of *L. megasoma*, but of darker color and softer texture. These differences may be, to some extent, however, owing to the advanced stage of decomposition of the specimen when examined.

ARTICLE V.—*On the Fauna of the Lower Carboniferous limestones of Spergen Hill, Ind., with a revision of the descriptions of its Fossils hitherto published, and illustrations of the species from the original type series.* By R. P. WHITFIELD.

The following species of fossils, with a very few exceptions, which are now for the first time described, were originally described and published, without illustrations, in the Trans. Albany Institute, Vol. IV, by Prof. James Hall, the paper being read before the Society in Nov. 1856. The collection of fossils is now the property of the Am. Mus. Nat. Hist., and as they are an extremely interesting group, the descriptions have been much sought after. But the volume in which they were published being out of print, and copies of it extremely scarce, it has been deemed advisable to reprint in the present form the original descriptions, with comments and comparisons, and to illustrate the species for the purpose of preserving the authenticity of the collection now in the Museum as types, and at the same time avoid the necessity of its being done elsewhere from other specimens than those originally used. It is almost universally considered necessary to refer to the individual specimens first employed in the establishment of a species, whenever identification of forms are questioned. Oftentimes where the types are not readily accessible others are figured, and in that way become more or less typical, but are never so satisfactory to the real investigator as a good figure of the original specimen, no matter how imperfect that specimen may have been.

The collection at the time it was being described in the autumn of 1856 was mounted on cards, and the names and measurements marked on the back, and it has not been disturbed or its condition changed except by the addition of a few better preserved specimens, which are marked, and of labels on the face of the card, corresponding to the name given on the back. In selecting the material for the illustrations there have been in some cases better specimens or larger ones used, but at least one of the original specimens of each species has been figured, and in all cases where others have been used, the fact is mentioned in the description of the figure on the explanation of the Plates. The descriptions were originally prefaced by some observations on the formations in which they occur, and on the other members of the Lower Carboniferous rocks, which have been superceded by subsequent publications, and which it is not necessary to repeat in this place. The formation in which the fossils are found, however, will need some remarks, for the purpose of localization.

The locality known as Spergen Hill (or Spurgeon's Hill), is near the railroad station of Harristown, a few miles S. E. of Salem, Washington Co., Ind. The formation has been considered as equivalent to the Warsaw division of the Lower Carboniferous limestones, but contains an intermingling of species known to occur in the Keokuk, Saint Louis and Chester limestones. The beds are exposed in the railroad cutting to a depth of fifteen or more feet, the greater part of the limestone being made up of these minute fossils. At Paynter's Hill, a short distance west of Spergen Hill (1½ m.?), the layers are exposed in the fields so as to become entirely weathered, forming a dark brownish-red soil, in which the fossils are often found entirely free from rock. At this locality the fossils are larger and somewhat differently preserved from those at Spergen Hill. There are also several species found here which do not occur at the former place. At Ellettsville, Ind., the same beds occur in great force, but do not contain very many fossils. The *Bellerophon* and *Euomphalus* occur quite abundantly however, and of very much greater size than at Spergen Hill. A portion of the beds at this locality, and at quarries near by, furnish much of the limestone used in the construction of the new State Capitol at Indianapolis. At Bloomington, Ind., it also occurs in pretty much the same condition as at Spergen Hill, but with fewer species and not usually as well preserved, being more chalky in composition and often more fragmentary, although many of them are of larger size. The formation has been observed at Alton, Illinois, where it is composed of thin shaly strata, bearing many of the characteristic species, but a much less number than at either Spergen Hill or Bloomington, while it is found to contain some that do not occur at any of the Indiana localities. Besides the layers which contain the fossils in such numbers, there are other beds similar in character or varying in composition, although classed as belonging to the same geological formation, (Warsaw or lower St. Louis) found at several localities in Indiana and abundantly used for building stone and known and described in the Indiana Geological Reports as Oolitic limestones. In some of these the Ooliths are concretionary in structure, while in the beds which contain such numbers of these fossils the oolith-like bodies are mostly foraminiferous, and consist largely of specimens of the *Rotalia Baleyi*, Hall.

The conditions which existed during the deposition of these peculiar limestones are not readily determined. They must have been peculiar in character, for while being such as would sustain animal life in great abundance, there seem to have been adverse conditions which caused the species to become dwarfed in size to a remarkable extent, especially so where the individuals are the most abundant. Many of the species have been recognized at other localities, some in the Chester limestones above and others in the Keokuk beds below, and nearly always attaining a greater size, although retaining all the specific features, showing these to be only diminutive representatives of species, which, in some cases at least, have been described as distinct. In the remarks added to the descriptions several of these are pointed out, they being most particularly noticeable among the Brachiopoda.

In describing the species in this paper, the original description and measurement given by the author of the species is retained, being given in quotation marks, while the remarks now added are printed in a leaded type. In the description of the *Brachiopoda* the terms "dorsal" and "ventral" were originally applied in the reverse order from that in which they are at present understood; but a correction is added in brackets; except in the case of *Athyris hirsuta*, page 49, first paragraph, where the author himself has added the correction.

DESCRIPTION OF SPECIES.

FORAMINIFERA.

Genus ENDOTHYRA.

Endothyra Baleyi, Hall's sp.; (*Rotalia Baleyi*, Hall ; *Trans. Alb. Inst., Vol.* 4, *p.* 34 ;—Comp. *E. Bowmani*, Phillips ; and *Involutina lobata*, Brady ; see Palæont. Soc. London, Vol. 30, p. 92, Pl. 5, figs. 1–4.) **Plate 9, Fig. 34–36.**

"Shell depressed-orbicular, sub-equally convex above and below, smooth ; margin rounded, indented by the septa ; spire depressed, involved ; last volution slightly oblique, consisting of eight loculi ; aperture contracted.

"The general form of this fossil is depressed-globular, with the involutions deviating slightly from the same plane. Not unfrequently, however, the spire ascends in a greater or less degree, and one or more loculi become visible beyond the single volution. Sometimes seven loculi only are visible in the volution. The surface is smooth under an ordinary magnifier, and the outline is indented at the septa.

"It gives me great pleasure to offer the slight tribute of the name of this ancient species to one who has done so much for science in our country, and of whom it would be superfluous for me to say, that he stands at the head of his department ;—of whose quiet, untiring zeal, patient investigation, and philosophical deduction, every student of science must speak with pride and satisfaction."

Mr. H. B. Brady in the Palæontological Society's papers above cited, has considered this species as the same with *Endothyra Bowmani* of Phillips, a common species in the Carboniferous limestones of England, Wales, Scotland and Ireland, and which is also found in other parts of the old world. The European examples, according to Mr. Brady's figures, correspond very closely with the American form, but are constantly of smaller size, and thinner and less robust in form. The number of segments is correspondingly variable in those of both countries, and consequently it becomes somewhat difficult to say why they should not be specifically identical. Forms of these low organisms, at the present time, are known to have a very extended geographical distribution, and it is probable they may have had in the more remote geological periods. It seems however, as if the constant difference in size and the less robust form of the European examples in such closely allied and minute organisms might be of specific importance. I have, therefore, thought it prudent to retain Prof. Hall's name rather than adopt for the American specimens the older one of Prof. Phillips. The American specimens are usually about one-twentieth of an inch in their diameter, while the European examples according to Mr. Brady seldom exceed one thirty-fifth of an inch.

Localities.—Spergen Hill and Bloomington, Ind., and Alton, Ill.

ECHNIODERMATA.

Genus PENTREMITES, *Say.*

Pentremites Koninckana, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 4;—*Geol. Iowa* 1858, *p.* 656, *Pl.* 22, *fig.* 11.) **Plate 9, Fig. 33.**

"Small, globose, or sub-pyriform, upper part rounded, base sub-pyramidal, angular; basal plates small, the lateral edges short and covered by the column, allowing the base of three of the radial plates to come within the limits of the column area, the two other plates resting upon the longer sides of the larger basal plates. Radial plates short, convex in the middle and sloping to the sides, widening a little from the base upwards, and divided only half way down for the reception of the pseudo-ambulacral areas; interradial plates minute, linear or tapering very gradually upwards to a point, and having two extremely short oblique sides below. Pseudo-ambulacral areas broad, nearly plane, and extending only about half way from the summit to the base, rather deeply impressed at their rounded lower ends; poral plates varying from 6 to 13. Oral aperture small, pentagonal; anal aperture large, oval; ovarian opening small, nearly round; surface very finely and beautifully striated; striæ on the sides of the radial plates nearly vertical, but on the lower part they are deflected obliquely across so as to meet at an obtuse angle on the centre below the ambulacral areas. Column at its junction with the body round, relatively very large.

"Length, one-twelfth to one-fourth of an inch.

"This species resembles *P. caryophyllatus* of De Koninck, (Crinoides du Terrain carbonifere de la Belgique,) but differs in the shorter base and peculiarity of the basal plates, as well as in the interradial plates, which in our species are extremely small and almost linear, the one on the annal side extending into that aperture. A single individual shows a nearly entire obliteration of one of the pseudo-ambulacral species."

The specimens described under this name are probably the young of *P. conoideus*, Hall. All the variations between them are in the direct course of development by additional growth. The short base, almost flat in the older specimens, is one of the most prominent characteristics of *P. conoideus*, but among a large number of small specimens of the species from the different localities none are found with flat bases, but as they increase in size this feature becomes more and more apparent. Occasionally medium sized individuals occur with unusually broad bases, giving them a more than commonly flattened form, but by far the greater number are the reverse in character.

Localities.—Spergen Hill and Bloomington, Ind., and Alton, Ill.

Pentremites conoideus, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 5;—*Geol. Rept., Iowa* 1858, *p.* 655, *Pl.* 22, *fig.* 8–10.) **Plate 9, Fig. 32.**

"General form conoidal or pyramidal with the angles rounded; base subtruncate; apex a little flattened; plates of the base rather flattened; radial plates extremely elongated and deeply divided for the reception of the pseudo-ambulacral areas; interradial plates deeply inserted between the radial plates, long lanceolate, and very acutely pointed above; pseudo-ambulacral spaces very elongate, narrow, extending nearly to the base, with sides subparallel, convex along the median line; median line sharply depressed; poral plates varying with age from 25 to 50; ovarian apertures circular; anal aperture ovate and much larger than the others. Surface marked by fine, closely arranged striæ, which on the radial plates are parallel to the margins till near the summit, where they are stronger and diverge from the centre; striæ on the interradial plates diverging from the centre.

"Length, from one-fourth to three-fourths of an inch.

"In young specimens the base is more extended and the poral pieces much fewer than in older specimens.

"Associated with this species, and having a similar general aspect, I have observed a single specimen, having a length of three-fourths of an inch, of an obtusely quadrangular form, and having but four pseudo-ambulacral areas, one of them being much wider than the others. There are, however, five ovarian openings at the summit. This appears to be an individual where the two adjacent sides of the radial plates have never been developed, while at the same time an effort has been made to preserve the symmetry of the ovarian openings."

This species differs from any of the many described from the carboniferous rocks of America in the conoidal form of the adult specimens, though young shells are common which present nearly the form of *P. pyriformis*, Say, and others that closely resemble *P. elegans* and *P. symmetricus*, Lyon. The preceding species comes first in the order as originally described by the author, but if they should be considered as belonging to the one species, *P. conoideus* should be retained for the species, as the other was founded upon immature specimens.

Locality.—This form has been recognized at Spergen Hill, Bloomington and Ellettsville, and at Paynter's Hill, Ind.; at Alton, Ill., if we consider the small individuals referred to *P. Koninckana*. It is also not uncommon near Boonville, Mo.

BRACHIOPODA.

Genus ORTHIS, *Dalman.*

Orthis dubia, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 12.) **Plate 6, Figs. 1-5.**

"Shell circular, or oval-ovate; valves nearly equally convex, the ventral [dorsal] valve somewhat more rotund; dorsal [ventral] valve flattened in the middle, with a broad depression extending thence to the front of the shell, giving it a sinuous outline; beak of dorsal [ventral] valve extended beyond the opposite valve, slightly incurved, with a triangular foramen; area very small, and (with the foramen of the dorsal [ventral] valve) nearly covered by the beak of the ventral [dorsal] valve, which curves towards the opposite valve, bringing the two almost in contact at their margins. Surface marked by fine rounded, closely arranged striæ, which increase by bifurcation and implantation; the striæ down the mesial depression are distinctly tubular, with minute, pore-like openings at intervals, directed downwards. These are probably the bases of minute tubular spines which were closely imbricated. Minute pore-like openings are sometimes seen on other parts of the shell, but never so conspicuous as in the dorsal [ventral] sinus.

"Length, .09 to .45, width .10 to .45 of an inch."

This species is more nearly allied to *Orthis Theimei* White, 1882.]

from the sandstones below the Burlington limestones at Burlington, Iowa, than to any other one. It differs, however, in the more pointed beak and rapidly sloping cardinal margins, in its narrower form and less regularly convex dorsal valve. The species is also remarkable for the thickening of the valves in older specimen, especially of the ventral valve. Subsequent collections have shown it to attain a considerably greater size than that given under the original description ; specimens from Paynter's Hill measure five-eighths of an inch in length. In such examples the striæ become very much elevated and exsert, and the shell remarkably thickened.

Localities.—Spergen Hill, Paynter's Hill, and Bloomington, Ind., and Alton, Ill. It is present in the Mus. Collections from the Keokuk limestones from Keokuk and Augusta, Iowa ; from Appanoose, Ill., and near Boonville, Mo.

Genus PRODUCTUS, *Sowerby.*

Productus biseriatus, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 12.) **Plate 6, Figs. 8–12.**

"Shell longitudinally ovate; dorsal [ventral] valve extremely gibbous, without sinus, arcuate, marked by five or six elevated distant concentric undulations which are ornamented upon their dorsal margins by a single row of elongate pustules or nodes; and on their middle and basal margins by numerous smaller granulations; beak attenuate and extremely arcuate; ventral [dorsal] valve semi-oval, flattened near the base, having the greatest concavity near the beak, which is obtuse; surface of the ventral [dorsal] valve marked by eight or nine closely arranged, concentric bands, which are marked by granulations as in the dorsal [ventral] valve; hinge line scarcely so wide as the greatest width of the shell; extremities rounded."

The specimens of this species present all the features of *P. vittatus*, Hall; Geol. Rept., Iowa, 1858, p. 639, but dwarfed. The smaller individuals are also closely similar to the form known as *P. alternatus*, Norwood and Pratten, 1854, which is perhaps not distinct from *P. vittatus*. There are great variations among the specimens usually included under the name *P. vittatus*, and the passage from one to the other extreme, as marked by the three forms, is so gradual that it is doubtful if they should not all be included under the one name of *P. alternatus*.

[*Oct. 20th,*

Localities.—Spergen Hill, Paynter's Hill, and Bloomington, Ind., and Alton, Ill.

Productus Indianensis, Hall ; (*Trans. Alb. Inst., Vol.* 4, *p.* 13.) **Plate 6, Figs. 6 and 7.**

"Shell sub-ovate, gibbous, inflated ; dorsal [ventral] valve without sinus, gradually contracting towards the beak which is large and strongly arcuate, obtuse at the extremity and very gibbous below; surface pustulose or aculeate, marked by extremely fine, concentric striæ, and a few irregular undulations; pustules or bases of spines irregularly distributed over the surface of the shell, with a linear series down each side below the hinge extremity ; hinge line apparently less than the width of the shell."

It is extremely difficult to point out differences between this and the preceding species. The specimens are a little more ventricose on the umbo of the ventral valve than those referred to *P. biseriatus,* while the entire shell is more rotund. The surface marking, what little there is left on the specimens, is of the same character precisely as on that one, so the specific distinction will have to rest entirely on the external form. I have seen interiors of dorsal valves of this form which have a thickened border very distinctly marked, and which have not shown any evidence of the concentric undulations. But there are none in the collection that can be figured.

Locality.—Spergen Hill, Ind.

Genus SPIRIFERA, *Sowerby.*

Spirifera bifurcata, Hall ; (*Trans. Alb. Inst., Vol.* 4, *p.* 8.) **Plate 6, Figs. 13–15.**

"Shell semi-elliptical in general form ; dorsal [ventral] valve gibbous ; ventral [dorsal] valve depressed convex ; plications, seven or eight, which appear to coalesce towards the cardinal margin ; mesial fold with a defined depression in the centre, reaching half way to the beak; surface longitudinally striated and concentrically marked by fine lines.

"Length, .09, width .11 of an inch."

The individuals of this species in the original collection are extremely minute, and bear evidence of immaturity. Among the later collections are a number of larger specimens and others of intermediate sizes, showing a tendency to greater development in

1882.]

the length of the hinge line and angularity of plications. The larger specimens present exactly the features of partially grown specimens of *Spirifera Leidyi*, N. & P. from the Chester limestones; and from this direction in the development by increased growth leave no doubt of these being dwarfed individuals of that species. A comparison of the three figures given, taking into consideration that they are enlarged six, three and two diameters respectively, will show this development of features.

Localities.—Spergen Hill, Ind.

Spiriferina Norwoodana; (*Spirifer Norwoodana*, Hall; *Trans. Alb. Inst. Vol.* 4, *p.* 7.) **Plate 6, Figs. 16 and 17.**

"Shell small, semi-elliptical, very gibbous, angles rounded; hinge line less than the greatest width of the shell. Dorsal [ventral] valve very convex and strongly arching near the beak, which is curved over the area; plications, about eight, the central ones very strong, and the mesial depression distinctly continued to the beak. Ventral [dorsal] valve ranging from depressed-convex to extremely convex, and marked by three strong plications on each side of the mesial fold, which has often a depressed line along the centre towards the base, with scarcely a distinct fold in the sinus of the dorsal [ventral] valve. Area small, high, not extending to the extremities of the hinge; foramen scarcely higher than wide; surface, in unworn specimens, marked by concentric, imbricating lamellæ.

"Length, .07 to .18, width .08 to .21 of an inch."

The shells of this species bear the the same relations to *Spiriferina Spinosa*, N. & P., that those of the above species do to *S. Leidyi*, except that these are rotund, in which feature they show more of an adult stage than do any of those of the other form. The shell of the best preserved specimen of this species preserves the spinose surface, and under a strong glass faint indications of the punctate structure so distinctive of *S. Spinosa* is discernable. As both *Spirifera Leidyi* and *Spiriferina Spinosa* occur of the normal form at three of these localities, it would be natural to suppose these dwarfed specimens may bear some close relations to those species.

Localities.—Spergen Hill, Ind., and Alton, Ill.

Genus ATHYRIS, *McCoy.*

Athyris hirsuta, Hall's sp.; (*Spirigera* (*athyris*) *hirsuta*, Hall; *Trans. Alb. Inst., Vol.* 4, *p.* 8.) **Plate 6, Figs. 18-21.**

"Shell varying in form from ovate to sub-circular; beak prominent, slightly extended, front compressed, sometimes faintly sinuate. Valves nearly equally convex, the dorsal (ventral) valve most convex towards the beak; beak of dorsal (ventral) valve prominent, incurved so as to bring the minute foramen nearly on a line with the margin of the shell; beak of the smaller valve closely incurved beneath the beak of the opposite valve. Surface ornamented by concentric, imbricating lamellæ, which give origin to successive rows of minute spines.

"The cast shows faint impressions of radiating striæ, which are not visible on the external surface of the shell. A narrow impressed line is sometimes shown down the centre of the cast of the dorsal [ventral] valve; and a few specimens have a shallow depressed groove down the centre of the shell from beak to base in both valves. A cast of a large individual shows about seven turns of the internal spire.

"From the foregoing description it will be seen that this species is closely related to the *Terebratula Royssii* of Leveille, and to *T. planosulcata* of Phillips. It differs from the first in its small size and more ovate form, especially of young individuals, and in never having the distinct sinus possessed by that shell; while the beaks of our shell are more prominent and the slope on each side is less concave. The volutions of the internal spire in *T. hirsuta* are not more than half the number represented in *T. Royssii.* From the *T. planosulcata* it differs in its small size, in being less ventricose, especially towards the front margin, in the proportionally more prominent beaks and generally more elongate form. From the specimens examined the projecting spinose lamellæ in our shell are never so much extended as in that species."

The specimens of this species obtained in later collections are very much larger than those originally used, some of those marked Spergen Hill measuring nearly three-fourths of an inch in diameter. Comparing these larger individuals, there is no perceptible difference between them and specimens of *Athyris sublamellosa*, Hall, from the Chester limestones. The figured specimen of the latter species, as given in the Geol. Rept. Iowa, 1858, Pl. 27, fig. 1, has a very ventricose dorsal valve; this, however, is by no means a constant character, and some of the Spergen Hill examples are fully as ventricose on that side. The Chester examples also develop, in extreme large growth, a deeper sinus and fold, but this feature is not seen in specimens when of the size of the large ones from Spergen Hill. I can see no essential distinction either between these and specimens from the Keokuk limestones usually referred to *A. planosulcata*, Phillips.

Localities.—Spergen Hill, Paynter's Hill and Bloomington, Ind., and Alton, Ill.

Athyris trinucleus, Hall's sp.; (*Terebratula trinuclea*, Hall; *Trans. Alb. Inst., Vol.* 4, *p.* 7;—*Geol. Rept. Iowa*, 1858, *p.* 659, *Pl.* 23, *figs.* 4 and 5.) **Plate 6, Figs. 22–27.**

"Shell sub-pentagonal or ovate, robust; trilobate, lobes nearly equal; valves nearly equal, the dorsal [ventral] one gibbous towards the beak, a sinus in the centre, beginning above the middle of the valve, gradually becoming wider and deeper towards the base, in some specimens distinctly bounded by an obtusely angular ridge. Ventral [dorsal] valve varying from sub-circular to transversely oval and longitudinally ovate, most convex between the centre and the beak, and distinctly trilobate, lobes extending about half way to the beak; the middle lobe often marked by a distinct linear depression; beak of dorsal [ventral] valve strong, rounded and incurved, truncated vertically by a distinct rounded foramen. Surface marked by fine concentric lines, which undulate with the lobes, and are extremely sinuous near the margin of the shell.

"Old shells are often marked by strong imbricating lamellæ at unequal distances.

"Length, .20 to .51, width .19 to .46 of an inch."

This species has proved to be an *Athyris* instead of a *Terebratula*, as at first supposed. The species is quite variable in form, and bears a striking resemblance to *Athyris subquadrata*, Hall; from the Chester limestone.

Localities.—Spergen Hill and Bloomington, Ind., Alton, Ill., and near Boonville, Mo.

Genus EUMETRIA, *Hall.*

Eumetria Verneuilana, Hall's sp.; (*Retzia Verneuilana*, Hall; *Trans. Alb. Inst., Vol.* 4, *p.* 9;—*Geol. Rept. Iowa*, 1858, *p.* 657, *Pl.* 23, *fig.* 1.) **Plate 6, Figs. 28–30.**

"Shell longitudinally ovate; valves almost equally convex; dorsal [ventral] valve most prominent near the beak, which is elevated and incurved so as to bring the circular foramen nearly on a line with the margins of the valves; foramen round; ventral [dorsal] valve smaller, auriculated on the cardinal angles, beak small, scarcely rising above the straight cardinal margin; area small, triangular, not entirely confined to the larger valve, bounded by a distinct angular margin. Surface longitudinally striate, marked by about fifty rounded, beautifully punctate, simple striæ.

"Length, .10 to .32, width .08 to .27 of an inch, usually. Some specimens have a length of three-fourths of an inch."

There is a very strong resemblance between the larger individuals of this species and specimens of *Eumetria* (*Retzia*) *vera*, Hall; Geol. Rept. Iowa 1858, p. 704, Pl. 27, fig. 3, but the latter species is not so ventricose, has not the beak so strongly incurved, has a larger cardinal area, and usually but not always stronger surface radii. The present form often attains a considerable size, especially those from Paynter's Hill, and sometimes become extremely ventricose.

Localities.—Spergen Hill, Paynter's Hill, and Bloomington, Ind., and Alton, Ill.

Genus RHYNCHONELLA, *Fischer.*

Rhynchonella subcuneata, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 11;—*Geol. Rept. Iowa,* 1858, *p.* 658, *Pl.* 23, *fig.* 3.) **Plate 6, Figs. 47–49.**

"Triangular, subcuneate; front rounded, meeting the lateral slopes at an obtuse angle; sides sloping to the beak and meeting at an angle of 60° or 65°; valves nearly equally convex, dorsal [ventral] valve most convex towards the beak; beak of dorsal [ventral] valve very acute, scarcely incurved, and perforate by a triangular foramen; beak of ventral [dorsal] valve acute, closely incurved below the triangular foramen. Surface marked by about twelve to fourteen (and rarely sixteen,) strong, simple, angular plications, which are somewhat obsolete near the beak; scarcely any indication of a sinus; plications crossed by fine concentric striæ, and in old shells, at irregular distances, by stronger imbricating folds or wrinkles parallel to the lines of growth; sides of both valves beneath the beak free from plications, and forming a very distinct elongate-oval space.

"Length, .16 to .41, width .15 to .39 of an inch."

This species in its cuneate form is somewhat peculiar among the *Rhynconellidæ.* It also has a perforation in the beak which is not a common feature of that genus, but it does not possess the features of the beak and deltidial portions shown in the *Rhynchonella* (*Rhynchotreta*) *cuneata* of the Niagara formations, and cannot be classed with those. The shell structure is decidedly fibrous, and the very young shells show the deltidium to be covered by a pair of minute plates with an opening in the upper part.

Localities.—Spergen Hill, Paynter's Hill, and Bloomington, Ind.

Rhynchonella mutata, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 10;—*Geol. Rept. Iowa,* 1858, *p.* 658, *Pl.* 23, *fig.* 2.) **Plate 6, Figs. 43-45.**

"Shell sub-trigonal, more or less gibbous, front broadly rounded or nearly straight, abruptly tapering to the apex, the two sides meeting at an angle of nearly 90°; ventral [dorsal] valve much more convex than the opposite one, which is often depressed, shell most convex near the anterior margin; beak of dorsal [ventral] valve nearly straight or but slightly incurved; foramen triangular; beak of the opposite valve obtusely angular and closely incurved against the dorsal valve. Surface marked by from twelve to sixteen strong, sub-angular plications, about four or five of which are depressed in the sinus of the dorsal [ventral] valve; sinus not deeply impressed on the margin of the shell; concentric striæ rarely visible.

"Length, .15 to .30, width .14 to .32 of an inch."

This is the largest of the Rhynchonellas found in these beds, after *R. subcuneata.* From the latter it is distinguished by its shorter and broader form, and from any of the other species associated with it by its coarser plications.

Locality.—So far as yet observed this species has not been obtained from these beds elsewhere than at Alton, Ill., but it has been observed in the Keokuk limestones just below the geode beds at Warsaw, Ill.

Rhynchonella macra, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 11.) **Plate 6, Figs. 40-42.**

"Shell triangular, flattened; apex acute; valves nearly equal; the dorsal valve a little more convex towards the beak, which is quite straight, extended beyond the lesser valve, and with a subtriangular foramen, which is slightly rounded above. Surface marked by from eighteen to twenty-four small, rounded plications which are about equal to the spaces between.

"Length, .15 to .24, width .14 to .29 of an inch."

The peculiar flat form of this species will readily distinguish it from the other associated species, except from the young shells of

R. mutata. From such specimens it will be almost impossible to separate them without leaving some question as to their identity.

Locality.—This, like *R. mutata*, has only been found at Alton, Ill.

Rhynchonella ricinula, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 9.) **Plate 6, Fig. 46.**

"Shell very small, longitudinally ovate or sublenticular, neatly rounded in front; valves almost equally convex; beak of dorsal [ventral] valve straight, comparatively much extended, perforate by a triangular foramen; surface marked by from twelve to sixteen angular plications, which often terminate abruptly about one-third of the distance from base to beak, sometimes becoming obsolete on the upper half of the shell.

"Length, .11, width .10 of an inch."

The minute size of this shell might readily be considered as its chief specific feature, were it not that the young of other species are found in the same rock. Those of *R. macra* so nearly resemble it as to preclude any possibility of distinguishing between them, except by the adult aspect which the shells of this species present. As no adult forms of *R. macra* have been found at Spergen Hill or Bloomington however, they will give but little trouble. The very young shells of *R. subcuneata* and *R. grosvenori* are often mistaken for this one, and I cannot see that there is any sure means of distinguishing between them.

Locality.—The type specimens are from Spergen Hill, Ind.

Rhynchonella Grosvenori, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 10.) **Plate 6, Figs. 31-34.**

"Shell globose, or sub-triangular, rotund or depressed; ventral [dorsal] valve more convex than the other, greatest convexity of the two valves near the front, sloping abruptly towards the beak where the two sides meet at nearly a right angle; beak rather small, neatly defined, nearly straight or slightly incurved, with a linear or sub-triangular foramen; beak of opposite valve round and obtuse, closely incurved. Surface marked by from fourteen to eighteen distinct rounded, simple plications, which often become obsolete towards the beaks; four or five of the folds depressed, forming a sinus on the larger valve, with a corresponding elevation of five or six plications on the opposite valve.

"Length, .14 to .22, width .13 to .23 of an inch."

The nearly globular, or depressed globular form will readily distinguish this from any other lower carboniferous species of the genus.

Localities.—Spergen Hill and Bloomington, Ind., and Alton, Ill.

Genus CAMAROPHORIA, *King.*

Camarophoria Wortheni, Hall's sp.; (*Rhynchonella Wortheni,* Hall; *Trans. Alb. Inst., Vol.* 4, *p.* 11.) **Plate 6, Figs. 35–39.**

"Shell small, longitudinally sub-trigonal, very abruptly tapering to the apex; ventral [dorsal] valve very convex or gibbous towards the front; dorsal [ventral] valve nearly flat and broadly sinuate in front, with a single broad, flattened plication, commencing near the margin, and filling a deep sinus in the opposite valve, corresponding to two short rounded plications on the front of the ventral [dorsal] valve; edges of the shell on each side of the mesial sinus sharply undulated, with indistinct marginal folds; beak of dorsal [ventral] valve pointed, straight, with a triangular foramen. Surface marked by fine concentric striæ, and some faint remains of finer radiating striæ.

"Length, .22, width .24 of an inch."

The generic relations of this species have not been absolutely determined, but it presents all the external features of *Camarophoria*, and shows some slight indications of the septa of the interior, but not enough to render its existence certain. Nearly all the Rhynchonelloid shells of this form in the carboniferous rocks of the west, which have been critically examined, prove to belong to this genus, and I feel inclined to think this one will also.

Locality.—Alton, Ill. Only two individuals of the species have been so far observed.

Genus TEREBRATULA, *Llhwyd.*

Terebratula turgida, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 6.) **Plate 6, Figs. 53–58.**

"Shell longitudinally ovate, often extremely gibbous, emarginate in front, dorsal [ventral] valve most convex in the middle, having a sinus extending to the base of the shell; beak large, rounded and prominent, incurved and pointed, with an oval or subcircular foramen just above or in the extremity. Ventral [dorsal] valve most convex in the middle or near the front, with or without a short sinus, in which is sometimes a short and obscure fold. Surface marked by strong concentric lines of growth; and near the front, in some shells, are strong wrinkles or folds which distort the form of the shell.

"Length, .16 to .32, width .13 to .27 of an inch."

This is a very good miniature representative of *T. sacculus*, Sow., of the Carboniferous limestones of Europe, but although recognized at many localities in this country, is never of such large size as is common with that species. It is very variable in its degree of ventricosity, sometimes increasing enormously in adult individuals, although they may be of small size. Some individuals have a thickness through the valves fully equal to the entire length of the shell.

Localities.—Spergen Hill, Bloomington, Paynter's Hill and Ellettsville, Ind.; Pella, Iowa; Warsaw and Alton, Ill., and near Boonville, Mo. At Warsaw, Ill., it occurs of more than three-fourths of an inch in length.

Terebratula formosa, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 6.) **Plate 6, Figs. 59–64.**

"Shell longitudinally oval-ovate; dorsal valve more convex in the middle and upper part; beak extended upwards, prominent, incurved; valves compressed near the front, which is neatly rounded, the margin presenting a slight undulation; sometimes sinuate in front. Surface marked by fine concentric lines of growth, and sometimes by parallel stronger folds or wrinkles. Under the magnifier the shell presents a finely punctate structure.

"Length, .14 to .44, width .10 to .31 of an inch."

This is a beautiful and generally a very symmetrical species, but it varys much in form and also in size. The typical specimens were scarcely half an inch long, but among more recent collections specimens measuring about one and one-half inches have been observed.

Localities.—Spergen Hill, Paynter's Hill, Bloomington and Ellettsville, Ind.; Alton and Warsaw, Ill.

Genus CENTRONELLA, *Billings.*

Centronella crassicardinalis, N. sp. **Plate 6, Figs. 50–52.**—Shell of about medium size and nearly circular outline, the length of the ventral valve being but slightly greater than the width; longitudinally it is strongly arcuate or curved from beak to base, but nearly flat transversely, except near the front where it becomes slightly sinuate. Beak of the ventral valve projecting beyond the hinge fully one fourth the length of the valve, with the cardinal slopes very large, broad and flattened, making the extreme posterior edge of the valve rather sharply angular. Foramen small and round; deltidial opening large and triangular; teeth strong. The interior of the valve seems to have been largely occupied by the muscular scars, while the cardinal edges of the valve have been greatly thickened, so as to present a very unusual character. Dorsal valve unknown. Surface, as indicated by the ventral valve only, marked by concentric varices of growth.

The shell differs from all the other species of the genus yet noticed, in the flatness of the ventral valve, this part generally being ventricose and sub-angular.

Locality.—Spergen Hill, Indiana. Known only by a single ventral valve.

LAMELLIBRANCHIATA.

Genus PTERONITES, *McCoy.*

Pteronites Spergenensis, N. sp. **Plate 7, Fig. 1.**—Shell very inequilateral and oblique. Hinge line a little less than the length of the body of the valve, and marked by a narrow, linear cardinal or ligamental area. In the left valve the anterior wing is of moderate size, elevated on the surface and rounded on the margin, separated from the body of the shell by a moderate depression; posterior wing large, pointed at the extremity, depressed on the surface so as to bring it entirely below the body of the valve; outer margin broadly sinuate. Body of the valve very ventricose, becoming almost subangular along the umbonial region. Beak large, prominent and projecting beyond the line of the hinge. Right valve unknown. Surface of the left valve marked by proportionally very strong concentric, lamellose striæ, which are very regular in their distances, and elevated so as to present almost the character of ridges on the body of the shell. Length of largest specimen observed, measured along the body of the shell, about .33, height about .20 of an inch.

Locality.—Spergen Hill, Ind.

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Genus NUCULA.

Nucula Shumardana, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 16.) **Plate 7, Figs. 2-6.**

"Shell obliquely ovate or sub-cuneate, gibbous towards the beaks; beaks anterior, elevated, approximate or in contact; anterior end vertically truncate; posterior side cuneate, sloping from the beak; cardinal line forming an angle of about 80° at the beak; base forming a broad curve from the anterior and posterior cardinal margins. Surface marked by regular equidistant, subimbricating striæ, rarely with unequal concentric folds. Hinge line somewhat strongly crenulate; ligamentary pit distinct, triangular.

"Length, .09 to .21, width .08 to .17 of an inch."

A very pretty species, and very closely resembling *N. parva*, McChesney, from the coal measures, both in size and form. In form it is very constant, the figures given being of the extremes found in the collection. The surface structure offers more variety, as some individuals are very regularly marked, and others are covered with strong varices, marking stages of growth. The dentition as obtained from separated valves is shown in fig. 6, Pl. 7, the teeth forming rounded tubercles.

Localities.—Spergen Hill and Bloomington, Ind.

Genus NUCULANA, *Link.*

Nuculana nasuta, Hall's sp.; (*Nucula nasuta*, Hall, *Trans. Alb. Inst., Vol.* 4, *p.* 17.) **Plate 7, Figs. 7-9.**

"Shell sub-ovate, abruptly contracted in front; posterior extremity rounded; beaks prominent, sub-central; anterior side shortest, and contracted both laterally and vertically into a proboscidial extension. Surface marked by regular lines of growth.

"Length, .14, width .09 of an inch."

In the above description the posterior side is referred to as anterior. In a specimen of very much larger size, obtained from later collections, (fig. 9) the proportions of parts are somewhat different from those of the type individuals, the posterior extension is less marked and the shell proportionally higher.

Locality.—Spergen Hill, Ind.

Genus CYPRICARDINIA, *Hall.*

Cypricardinia (?) Indianensis, Hall's sp.; (*Cypricardia Indianensis*, Hall, *Trans. Alb. Inst.*, *Vol.* 4, *p.* 18. **Plate 7, Figs. 10-14.**

"Shell elongate-ovate, narrow and rounded in front; posterior end broader, somewhat compressed and subulate; base broadly curved; hinge line straight, less than the greatest length of the shell; a line or groove on the inner margin extending from the beak to the posterior extremity; beaks very small, near the anterior end; umbonial region gibbous. Surface marked by distinct, regular, imbricating lamellæ.

"Length from one-eighth to three-fourths of an inch."

The species appears to have all the external features of the genus *Cypricardinia*, Hall, both in the character of surface markings and in the general form and inequality of the valves; but the hinge dentition is somewhat different as shown on two right valves, and partially on others, from what I had supposed existed in that genus. So far as I am aware the hinge of *Cypricardinia* has never been fully determined from any characteristic species of the genus, but I have preferred to place it provisionally under that head rather than risk making a synonym by proposing a new generic name. It certainly does not belong to *Cypricardia*, but is more closely allied to the *Arcidæ*, and would be near *Macrodon* were it not for the inequality of the valves.*

Localities.—Spergen Hill and Bloomington, Ind., and Alton, Ill.

Genus CONOCARDIUM, *Bronn.*

Conocardium catastomum, Hall; (*Trans. Alb. Inst.*, *Vol.* 4, *p.* 13.) **Plate 7, Figs. 15-17 a.**

"Shell very small, elongate, sub-cylindrical or subclavate, gibbous in the middle; beaks minute, rising slightly above the hinge line, and anchylosed, anterior end obliquely truncated and obtusely angular on the umbonial slope; the anterior tubular wing minute; posterior end much extended, and constricted near the middle, swelling at the extremity and gaping below. Surface marked with small simple radiating folds which sometimes become obso-

* Some of the Arciedæ are unequivalve, but the inequality is of a different kind from what we see here, being caused by the less extension of the front margin of one valve, while here the entire valve is less ventricose as in *Periploma*.

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lete on the anterior end and umbones. Minute undulating concentric striæ cross the radiating folds in well preserved specimens.
"Length from .125 to .20 of an inch."

The most peculiar feature of this species consists in the anchylosis of the valves along the hinge margin. Between the beaks there occurs a small tubercle of solid deposit, firmly uniting them, and often extending along the hinge in form of a callus. This feature not only occurs in adult individuals, but is also seen on many of small size to so great an extent as to have apparently precluded the possibility of any motion of the valves along the cardinal line. From the examination of a large number of individuals I believe, however, that the feature is caused by a deposit of compact, crystalline carbonate of lime on the inside of the shell after death, which has to some extent forced the beaks asunder and filled the space. On the removal of the chalky substance of the shell this layer is exposed, thus producing the appearance of anchylosis. In cutting specimens across at the beaks this feature is readily seen in section, the layer of carbonate of lime lining the entire extent of the shell. The idea of a perfect anchylosis of the beaks of a bivalve, it appears to me, is incompatible with the further growth of the shell, and especially so where there is a long hinge line. If in the case of this shell the apparent soldering of the valves at the beaks and along the hinge had occured, they never could have been separated in front for the admission of water or additional growth, and would as a matter of fact have resulted in the death of the animal. The minute size and peculiarly constricted form of the species, sometimes in the younger stages of growth being almost cylindrical, is a very marked and distinguishing character of the species.

Localities.—Spergen Hill, Ind.; and so far not found elsewhere.

Conocardium carinatum, Hall; (*Trans. Alb. Inst. Vol.* 4, *p.* 14.) **Plate 7, Figs. 18 and 19.**

"Shell subtrigonal, gibbous in the middle, anterior end cordate; hinge line straight; beaks very small, strongly incurved, rising little above the hinge line; posterior side straight above, sloping upwards from below, and gradually tapering to the extremity, faintly constricted at its junction with the body of the shell and gaping below; hiatus elongate-lanceolate, crenulate; umbonial slope strongly carinated; carina reaching from beak to base where it is strongly salient; anterior side obliquely truncate, and abruptly produced into a small conical tubular extension of the hinge line. Surface marked by simple radiating ribs and extremely fine concentric striæ, which in passing over the ribs give the surface a granulated appearance. On the anterior slope the ribs are finer and closer than on the sides of the shell, and strongly curved.

"Length, from .20 to .33 of an inch."

The carina which forms a crest along the anterior umbonial ridge constitutes the distinguishing feature of this form. In other respects it does not appear to differ from *C. cuneatum*, Hall; and, as many specimens are found which are intermediate between the typical specimens of the two, it is probable they are only varieties of the one species.

Localities.—Spergen Hill and Bloomington, Ind.

Conocardium cuneatum, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 14.) **Plate 7, Figs. 24-26.**

"Shell sub-trigonal or abruptly clavate; hinge line straight; beaks anchylosed, incurved, very small, rising but little above the hinge line; umbonial slope angular; anterior side truncate, concave just within the angle of the umbonial slope, convex in the middle, and abruptly produced above, in continuation of the hinge line, in a tubular wing; posterior side vertically compressed, straight along the hinge line, and abruptly declining at the extremity, sloping along the base from the centre of the shell to the extremity. Hiatus elongate, extending forward to near the middle of the shell, rounded and expanded at the posterior extremity, and deeply crenulate in the margins of the narrower part. Surface marked by distinct radiating costæ, which often alternate in size or bifurcate on the posterior part of the shell; crossed by fine elevated concentric lines of growth, more or less closely arranged. Near the basal margin are some stronger subimbricating ridges parallel to the lines of growth.

"Length, .33 to .50 of an inch."

The remark "beaks anchylosed" as applied to this species cannot have the same signification as it does in the case of *C. catastomum*, as the most perfectly preserved specimen in the collection has the beaks clean, clear and perfectly free from each other, without any deposit or thickening of any kind between them. The suture of the hinge between the beaks and elsewhere is sometimes very close, and in some cases where the shells have

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been dead and eroded previous to being imbedded, the line has become entirely obliterated by emaceration. This I presume is what is meant by the statement. The hiatus, or gaping of the valves on the postero-basal line, is sometimes very marked and the thickening of the internal ribs so prominent as to form strong interlocking teeth along the narrow part of it.

Localities.—Spergen Hill and Bloomington, Ind.

Conocardium Prattenanum; (*Trans. Alb. Inst., Vol.* 4, *p.* 15.) **Plate 7, Fig. 20.**

"Shell sub-fusiform; hinge line straight, beaks depressed, distinctly anchylosed; from the beaks along the anterior umbonial slope, [the] angle [is] obtuse and scarcely defined; anterior side obtuse, convex in the middle, and gradually sloping upwards from the angles; posterior part of the shell with a broad depression on each side, and again expanding at the extremity with an oblique angular fold, from the hinge line downwards to the hiatus; hiatus broad and expanded behind, narrowed abruptly at the junction of the oblique folds, and thence gradually to the middle of the shell. Surface marked by strong plications, which are much stronger on the anterior part of the shell, and more slender behind. The fold along the anterior umbonial slope bifurcates, sending off on each side a plication, which again bifurcates. Plications crossed by sharply elevated lines, which are more conspicuous on the posterior part giving it a cancellated appearance.

"Length, .20 of an inch."

Of this species a single specimen only exists in the collection. The beaks and upper part of the anterior face of the valves are imperfect, and the apparent anchylosis may be and probably is deceptive. The species is a very distinct and well marked one, differing materially from all the others in the collection in the few strong plicæ of the anterior end, and the stronger bifurcating plications of the anterior umbonial ridge.

Locality.—Alton, Ill.

Conocardium Meekanum, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 15.) **Plate 7, Figs. 21-23.**

"Shell sub-angularly ovate or abruptly clavate; hinge line nearly straight, declining at the posterior extremity and sometimes from the beaks; obliquely truncated anteriorly; anterior end convex in the middle, and margined by a narrow sulcus which reaches from beak to base just within the obtuse angle of the umbonial slope; posterior end sloping on the base uniformly from the centre of the shell to the extremity, contracted behind the body of the shell; vertically depressed and slightly expanded laterally at the extremity. Surface marked by small, elevated, thread-like radiating lines, which on the posterior part of the shell are crossed by finer concentric striæ, giving that part of the shell a cancellated appearance. Anterior depressed end marked by much fainter radiating lines crossed by nearly obsolete traces of fine striæ, which converge towards the anterior tubular wing.

"Length, .20 to .33 of an inch."

The shells of this species bear considerable general resemblance to those of *C. cuneatum*, but are generally smaller. They vary considerably also among themselves as do those of that species. The one figured is of the broadest or most obtusely cuneate form; others being very much more slender and the umbonial ridge more oblique. One distinguishing feature between the two is in the coarser striæ marking the anterior end of the shell of this one, which are not regularly concentric as in *C. cuneatum*, but successively diverge from the umbonial ridge. The material in which the shells are preserved is well calculated to retain all the surface markings, and consequently the cancellation of the surface is beautifully preserved.

Locality.—Alton, Ill.

Conocardium equilaterale, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 16.)

"Shell triangular, sub-equilateral, scarcely gibbous in the middle; hinge line very straight; beaks small, rising a little above the hinge line; anterior end cuneate, sloping gradually from near the centre of the shell; umbonial ridge obtuse above, nearly at right angles to the hinge, and sub-dividing several times before reaching the base; posterior end cuneate, very gradually sloping from the body of the shell; extremity unknown. Surface marked by radiating striæ or folds, which are simple or bifurcating, and crossed by fine, regular, elevated, thread-like lines.

"Length and width nearly equal, about .125 of an inch."

Only a single individual of this species was obtained in all of the collections examined, and this has not been found in the collection since it came into the possession of the Am. Mus. Nat. History. Consequently I have not been able to give illustrations of the species.

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Observations of the Genera MICRODON, *Conrad*, and CYPRICARDELLA and EODON, *Hall*.

In the original Spergen Hill paper, the genus *Cypricardella* is proposed for a group of similarly formed species which are somewhat abundant at one of the localities. Three of these species, *C. sub-elliptica*, *C. nucleata*, and *C. oblonga*, have certain characteristics common to each. A fourth included in the genus (*C. plicata*) possesses different features and belongs to an entirely distinct group.

The three species above alluded to are more or less quadrangular in form, with a slight umbonial ridge crossing the shell from the beak to the postero-basal angle, and the surface is marked by comparatively regular, elevated, concentric lines, which are bent abruptly in crossing the umbonial ridge referred to. The hinge plate in the interior is characterized in the right valve by a single well defined, triangular tooth, and an equally well defined triangular cavity behind it, which is bounded by a less distinct ligamental ridge further back. The ligament has been external, and the muscular scars are large and well defined. The pallial line is simple, and the shells are moderately ventricose and have a decidedly impressed escutcheon and lunular area. If one examines the shells and internal imprints of *microdon bellistriata*, Conrad, from the Hamilton shales of New York, all these features will be found to appear equally strong, and as distinctly marked, except the ventricosity of the valves as they are on the Spergen Hill specimens, only on a much larger scale. The greater flatness of the valves in the New York specimens is readily accounted for by the greater amount of compression which has taken place in the shales than in the limestones of the western locality. Had the genus *Microdon* been as well understood at the time *Cypricardella* was proposed, as it has become since, I doubt if the name would have ever appeared. The shells described under it are such perfect miniatures of the Hamilton forms that one is at once impressed by the perfect resemblance.

The name *Microdon* had been applied by Prof. L. Agassiz to a group of fishes previous to its application to these shells by Conrad, (which I have spoken of elsewhere) and by some it has been thought unadvisable to retain it for this group on that account. In the Cat. Am. Pal. Foss., S. A. Miller, 1877, p. 244, Prof. Hall proposes to substitute the name *Eodon* for it, but it seems to me that if it is to be substituted at all, that of CYPRICARDELLA should be retained.

Genus MICRODON, *Conrad.*

Microdon (Cypricardella) sub-elliptica; (*Cypricardella sub-elliptica*, Hall; *Trans. Alb. Inst., Vol.* 4, *p.* 17;—*Geol. Rept. Iowa*, 1858, *p.* 664, *Pl.* 23, *figs.* 11 and 12.) **Plate 7, Figs. 27-29.**

"Shell sub-elliptical, obliquely truncated at the posterior end; beaks minute at the apex, rising little above the hinge; umbones sub-gibbous, with an undefined elevation extending obliquely towards the posterior basal margin; anterior end narrower than the posterior, rounded at the extremity. Cardinal margin forming an angle with the beak of 25°; base forming a regular elliptical curve. Surface marked by regular, fine, concentric elevated lines which are equal to the spaces between.

"Length, .19 to .32, width .14 to .24 of an inch."

The proportionally greater height or shorter form, with rounded anterio-basal and posterior margins, will sufficiently distinguish this one from either of the other species associated with it.

Localities.—Spergen Hill and Bloomington, Ind.

Microdon (Cypricardella) nucleata; (*Cypricardella nucleata*, Hall; *Trans. Alb. Inst., Vol.* 4, *p.* 17;—*Geol. Rept. Iowa*, 1858, *p.* 664, *Plate* 23, *fig.* 10?) **Plate 7, Figs. 35-36.**

"Shell inequilateral, sub-quadrangular, gibbous; anterior end short, rounded; posterior end broader, abruptly compressed, vertically truncated at the extremity; beak nearer the anterior end, small; posterior umbonial slope extremely gibbous (a broad undefined ridge) reaching to the base of the truncation. Surface marked by fine regular concentric lines parallel to the border of the shell.

"Length, .11 to .13, width .08 to .10 of an inch."

This is the smallest form observed, and is of nearly equal height and length in its typical form, but specimens of larger size are proportionally longer, as they increase more in length than in height with increased growth. In consequence of this feature it becomes very difficult if not impossible to distinguish between medium sized individuals of *M. oblonga* and large individuals of

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this species, and leads one to suspect they may both belong to one species, especially as the surface markings bear the same proportions to the shell as do those of that species when of the same size.

Localities.—Spergen Hill and Bloomington, Ind.

Microdon (Cypricardella) oblonga; (*Cypricardella oblonga*, Hall; *Trans. Alb. Inst.*, *Vol.* 4, *p.* 18;—*Geol. Rept. Iowa*, 1858, *Pl.* 23, *fig.* 10?) **Plate 7, Figs. 30–34.**

"Shell oblong, sub-quadrangular; anterior end narrow, rounded; posterior end broader, flattened, and almost vertically truncate; cardinal margin nearly straight and horizontal behind, declining in front; base nearly parallel to the hinge line; beaks small, somewhat prominent, gibbous below; posterior umbonial slope gibbous or sub-angular, and extending obliquely downwards and backwards to the base of the truncation; lunule small, ovate, deep in the centre; escutcheon linear, distinct.

"Length, .09 to .30, width .06 to .20 of an inch."

This species occurs of larger size than either of the others associated with it. When small it is nearly equally high and long, but becomes gradually longer in proportion as it increases in size, so that specimens are often found much more than half as long again as high. In the Geol. Rept. Iowa, 1858, Pl. 23, fig. 10, a specimen of this species is figured as *C. nucleata*, probably by mistake. The specimen is one of the original series, and has always been attached to the card marked *C. oblonga*. It corresponds exactly in size to the measurements given of that species in the original description, being .30 of an inch long and .20 wide; while no measurements are given of *C. nucleata* exceeding one-half the width, and but little more than one-third the length.

Localities.—Spergen Hill and Bloomington, Ind.

Microdon (Cypricardella) sp.? **Plate 7, Fig. 37.**—Several examples of a shell resembling *M. oblonga* in its proportions of length and breadth, and having an elliptical outline corresponding somewhat to *M. sub-elliptica*, have been observed among the later collections from Spergen Hill. It does not appear to be distinct enough from the other forms to be entitled to rank as a distinct species, but appears to unite the two. A figure of one of them is given that attention may be directed to it, with the hope of obtaining further information.

Genus GONIOPHORA, *Murch.*

Goniophora plicata; (*Cypricardella plicate*, Hall; *Trans. Alb. Inst., Vol.* 4, *p.* 18.) **Plate 7, Fig. 39.**

"Shell oblong, sub-quadrate, hinge line slightly arched, the base and hinge line nearly parallel; gibbous in the middle above, and anteriorly, depressed in the middle towards the base; beaks near the anterior end, small, and scarcely rising above the hinge margin; anterior end short, scarcely extending beyond the beak, rounded; posterior extremity doubly truncate; a strong fold or angulation extending from the umbo to the posterior basal margin, and a smaller similar fold midway between that and the hinge line, the intervals on the margin between these being truncate. Surface marked with concentric lines of growth.

"Length, .12, width .12 of an inch."

The hinge margin of this species is bounded by a narrow escutcheon, and the ligament has been external. These features together with the general form of the shell would throw it into the genus *Goniophora* unless the hinge features may differ, which is scarcely probable. The only other genus to which it has much resemblance is *Pleurophorus*, to which externally however it is not so nearly related.

Localities.—Spergen Hill and Bloomington, Ind.

Genus EDMONDIA, *DeKon.*

Edmondia subplana (*Cypricardia subplana*, Hall; *Trans. Alb. Inst., Vol.* 4, *p.* 19.) **Plate 7, Fig. 38.**

"Shell ovate oblong; anterior end very short; posterior end extremely elongate, very gradually narrowing to the extremity which forms a symmetrical elliptic curve; cardinal and basal margins nearly parallel; beaks small; umbonial region depressed convex. A few obsolete concentric folds visible on the surface; intermediate portions, probably, finely striate.

"Length, .69, width .38 of an inch."

All the examples of this species which have been observed are imperfect. The type specimen (fig. 19) is very much water-worn, and although the hinge margin of the shell is very well exposed, it presents no dentition whatever. A second specimen of about the same size, a partial cast, shows a rather large posterior muscular imprint situated near the cardinal margin; but the anterior end is more imperfect. The structure of the hinge so far as

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revealed, a simple margin with probably an external ligament, will come nearer to the characters of the genus *Edmondia* than to any other known carboniferous form. It certainly is not a *Cypricardia*, as that genus is known from recent species.

Localities.—Spergen Hill and Bloomington, Ind.

GASTEROPODA.

Genus PLATYCERAS, *Conrad.*

Platyceras acutirostris (*Capulus acutirostris*, Hall; *Trans. Alb. Inst., Vol.* 4, *p.* 31;—*Geol. Rept. Iowa*, 1858, *p.* 665, *Pl.* 23, *fig.* 14.) **Plate 8, Figs. 13–15.**

"Shell obliquely conical, more abruptly contracted above, and continued in more slender proportions to the apex, which is incurved, making about a single volution without contact with the body of the shell; aperture sub-circular, margin sinuate; surface sub-plicate, with narrow sub-angular folds and wider depressed spaces; lines of growth strong, abrupt upon the angles and arching forwards on the spaces between."

There is a very great degree of variability among the specimens of this species, even at the typical localities, and particularly so when a more extended geographical distribution is considered. In the degree of expansion of the shell it is particularly variable, and also in the number and arrangement of the plicæ and consequent sinuses of the margin. The apex of the shell may also be short and minute, or long, pointed or enrolled.

Localities.—Spergen Hill, Paynter's Hill, Ellettsville, Bloomington, and Crawfordsville, Ind. Warsaw and elsewhere in Ill., and Tuscumbia, Ala.

Genus LEPETOPSIS, New Genus.

Shell patelliform, more or less regularly round or oval, apex sub-central, posterior to the middle and directed backward, the nucleus dextrally coiled; muscular imprint horseshoe-shaped, open (?) in front, consisting of an irregular narrow band which expands more or less at the anterior extremities. Surface of the shell marked by six very indistinct radiating lines, two anterior, two posterior, and two lateral. Type *L. Levitte*, White.

It seems as if there were already genera enough among the shells of this group to include any new form that might be discovered, but there is certainly need of some designation other than any existing one, under which forms of this kind that are comparatively numerous in the carboniferous limestones, can be placed. They have been usually called *Patella* or *Capulus*, and are often doubtfully referred to *Metoptoma*, but it is quite certain they do not properly belong to either of these genera. *Metoptoma* proper is a very distinct form, and Prof. Phillips, even when proposing that genus, referred forms congeneric with this one to *Patella*. It certainly seems like straining a point to refer these carboniferous shells to a living genus, simply on their general form, when among the living ones such diverse characters are found in the animals as to require several genera, where the shells are undistinguishable from external form alone. I have therefore preferred to risk proposing a new name rather than to refer them to a genus to which I am certain they do not belong. I am slightly in doubt concerning the opening in the muscular impression on the anterior side, as I have not been able to fully see this part. The genus bears some relations to *Anisomyon* M. & H. (see Invest. Pal. U. S. Geol. Surv. Territ., p. 285,) in its general appearance, but the nucleus is not reversed and the radiating lines are external, while those of that genus appear strongest on the inside, as ridges.

Lepetopsis Levettei, (*Patella Levettei*, White ;—*Geol. Ind., 11th Rept., p.* 359, *Pl.* 39, *figs.* 4 *and* 5.) **Plate 8, Figs 9-12, and Fig. 8 ?**

Shell nearly regularly oval in outline, moderately to depressed convex; apex minute, slightly posterior to the middle of the length; anterior end of the shell more highly convex than behind, the latter portion slightly concave just behind the apex; shell somewhat lamellose in structure and marked by concentric lines of growth; the radiating lines which mark the surface are very faint or obsolete; when seen they divide the shell into six nearly equal parts; length of largest specimen one inch and one tenth; width a little less than one inch.

In the collection there are two shells, one of which is represented by fig. 8, which appear to be the apical portions of a larger specimen; but possibly they may belong to this species, as both individuals figured show that the apex has been less rapidly expanding than the shell below. It is possible they may represent a distinct species, but they appear so immature that I hesitate to consider them in that light.

Locality.—Spergen Hill, Ind.

Genus EUOMPHALUS, *Sowerby.*

Euomphalus Spergenensis, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 19. *Straparollus spergenensis* (Hall) *S. A. Miller, Cat. Am. Pal. Foss.*) **Plate 8, Figs. 16–19.**

"Shell sub-discoid or planorbiform; spire composed of five or six turns, the inner ones coiled in the same plane, two or three of the outer ones only visible in profile; suture well defined on both sides; volutions rounded below with a distinct obtuse angulation on the upper side, a little distance from the suture; umbilicus nearly twice the breadth of the outer volution; aperture oblique, round-oval, with a slight expansion at the angle on the upper side of the volution. Surface marked by close, fine, equal striæ of growth.

"Diameter .30 to 1 inch; height .23 to .45 of an inch.

"This shell resembles the *E. lævis* of D'Archiac and DeVerneuil (Trans. Geol. Soc. Lond., vol. vi, 2d series, part 2, p. 363, plate 33, fig. 7). *E. planorbis* in part of De Koninck. (Carb. Fossils of Belgium, page 434, plate 25, fig. 7).

"Our shell agrees with the description of MM. D'A. and De V., with the exception of the form of the aperture. The figures given by these authors show the greatest diameter of the aperture to be transverse, while in the species here described the longest diameter is obliquely outwards and downwards from the axis of the shell. Our shells with five turns of the spire are much smaller than *E. lævis* of these authors, and our larger specimens are precisely of the same size as the four inner volutions of their figure.

"It is possible, however, that these deviations which appear constant in our specimens may prove to be only a variety not of specific value. Our specimens of this species, which are numerous, do not lead us to include the *E. planorbis* of D'A. and De V. as a variety."

The shells of this species are extremely variable, and where large collections of the various stages of growth are examined together, it becomes totally impossible to draw lines of distinction

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between this and the other three forms associated with it. The var. *planorbiformis* differs only in the depression of the spire to nearly the plane of the outer volution, the number of volutions even here varying considerably. *E. planispira* has the volutions more slender as well as more numerous, and often the spire becomes so depressed as to present but very little difference between it and the umbilical side. The form originally given as *E. quadrivolvis* is perhaps more distinct and more readily distinguished than any of the others, still intermediate forms are so numerous as to cause great trouble in separating it from the more rapidly expanding specimens of *E. Spergenensis.* As the surface markings are alike in all the four varieties, it becomes a question as to whether they may not all belong to one very protean species. However, as they have been described as distinct forms I have given illustrations of each, that others may form their own conclusions.

Localities.—The typical form of *E. Spergenensis* has been observed at Spergen Hill and Paynter's Hill, Bloomington and Ellettsville, Ind. The other forms have been observed at each locality mentioned except Ellettsville, where it is possible they may occur, as I have seen but few specimens from that locality.

Euomphalus Spergenensis *var.* **planorbiformis,** Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 20. *Straparollus Spergenensis,* var. *planorbiformis* (Hall) *S. A. Miller; Cat. Am. Pal. Foss.*) **Plate 8, Figs. 20 and 21.**

"Shell discoid; spire flat or concave; volutions about four, rounded above and below; aperture nearly circular; umbilicus broad, not deep."

Euomphalus planispira, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 20. *Straparollus planispira* (Hall) *S. A. Miller; Cat. Am. Pal. Foss.*) **Plate 8, Figs. 22 and 23.**

"Shell discoid; spire flat or scarcely concave; volutions about five or six, slender, very gradually increasing in size, rounded above and below; suture well defined; aperture circular; umbilicus broad and shallow. Surface marked by fine, closely arranged and slightly undulating striæ.

"Diameter .36; height .12 of an inch."

"This shell is distinguished from either of the preceding by its slender volutions which increase much more gradually from the apex. The volutions are round both above and below, though sometimes the lower side descends so abruptly to the umbilicus as to present the appearance of an obtuse or undefined angle on the last volution."

Euomphalus quadrivolvis, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 19. *Straparollus quadrivolvis* (Hall) *S. A. Miller; Cat. Am. Pal. Foss.*) **Plate 8, Figs. 24 and 25.**

"Shell planorbicular, spire depressed, composed of about four turns, the inner one scarcely rising above the last volution; volutions somewhat rapidly increasing from the apex, regularly rounded; aperture round-oval, slightly transverse; umbilicus less than the diameter of the outer volution. Surface marked by fine, closely arranged striæ of growth.

"Diameter .12 to .31; elevation .06 to .16 of an inch."

There is so much confusion in regard to the value of the names *Euomphalus* and *Straparollus* that I have preferred to leave these species where they were originally placed, rather than to burden the science with additional and useless references by changing them under uncertainty.

Genus NATICOPSIS, *McCoy.*

Naticopsis Carleyana; (*Natica Carleyana*, Hall; *Trans. Alb. Inst., Vol.* 4, *p.* 31.) **Plate 8, Figs. 26 and 27.**

"Shell sub-globose; spire short, consisting of about three volutions, which increase very rapidly, the last one extremely ventricose; suture not distinctly defined; aperture ovate, straight on the columellar side; outer lip sharp; inner lip thickened; columella with a distinct groove near the base of the lip for the reception of the operculum; surface marked by fine elevated striæ corresponding to the lines of growth.

"Height .10 to .30; diameter .08 to .34 of an inch."

This species is very closely related to *N. nana*, M. & W., from the coal measures of the Western States, and if mingled with specimens of that species of the same lithological character it would be difficult to separate them. The inside of the aperture on the columellar side is thickened, and the shell imperforate, which characters would remove it from the genus *Natica* to NATICOPSIS. Among some later collections there are specimens which measure fully one-half inch in height, being much larger than those in the original collection.

Localities.—Spergen Hill and Bloomington, Ind., and Alton, Ill.; being very rare at the latter locality, while extremely abundant at that first mentioned.

Genus MACROCHEILUS, *Phillips.*

Macrocheilus Littonanus (*Natica Littonana*, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 30.) **Plate 8, Fig. 28.**

"Shell short, sub-fusiform; spire depressed-conical; volutions about four, rapidly increasing from the apex, the last volution symmetrically ventricose and prolonged below; suture not strongly marked; aperture narrow-ovate, sharp above, and narrowing near the front; outer lip thin; inner lip thickened; surface striated.

"Height .25; diameter .19; last volution .17 of an inch."

This shell is very erect in form, the columella forming the central axis, unlike any form of *Natica.* The columella of the only specimen in the collection indicates the existence of a very slight twist, showing the features of the genus MACROCHEILUS to which I have referred it. The surface under a strong hand-glass appears to me to be entirely destitute of markings of any kind, and the suture line between the volutions to have been partially obliterated by a deposit like that of the recent *Ancillaria.*

Locality.—Bloomington, Ind.

Genus HOLOPEA, *Hall.*

Holopea (Callonema?) Proutana, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 30.) **Plate 8, Figs. 33 and 34.**

"Shell ovate-conical; spire somewhat rapidly tapering; volutions about six; moderately convex, last one ventricose, subangular in the direction of the suture line, and obliquely extended below; suture sharply defined; aperture round-ovate, oblique on the upper side; pillar lip slightly reflexed in the umbilical region; umbilicus none; surface marked by fine striæ parallel to the lines of growth.

"Length .62 to .50 of an inch."

There is considerable variation in the ventricosity of the volutions in this species, some of them being decidedly flattened in the direction of the spire, while others are quite round and the suture line very distinct. The angulation at the outer base of the last volution is also often obsolete. The shell is minutely perforate, and has a decided umbilical depression at the top of the columella.

Its generic relations with *Holopea symmetrica*, Hall, the first species of the genus described is not very close, but perhaps as near as to any other described genus. It has exactly the characters of *Callonema*, Hall, as shown in *C. bellatula*, except in the surface ornamentation, which is given by the author as a generic feature; although *C. bellatula* and especially the New York form of it, known as *C. Lichas*, frequently becomes nearly smooth toward the aperture in old shells.

Localities.—Spergen Hill and Bloomington, Ind., and Alton, Ill.

Observations on the Genera BULIMELLA and POLYPHEMOPSIS.

In the original paper on the Spergen Hill fossils, the author proposed the name *Bulimella* for a group of Gasteropods closely resembling the recent *Achatinas*. The name however had been previously employed by Pfeiffer for a genus in the same class, and this later one consequently becomes a synonym. Subsequently Messrs. Meek and Worthen, in the Geol. Rept. Ills., Vol. II, p. 372, refers the shells upon which the genus was founded to *Polyphemopsis*, *Portlock;* and also two others, generically identical, previously described as species of *Loxonema*. So far as I can understand from the remarks made by Capt. Portlock in proposing the genus *Polyphemopsis*, he founds it upon Sowerby's *Polyphemus fusiformis*, a species placed by Prof. Morris and other European authors under the genus *Macrocheilus*, established two years before *Polyphemopsis* and recognized by Capt. Portlock. If this reference is correct, as I believe it is, it destroys Portlock's genus, as it takes away his type. If we consider *P. elongatus* as the type, it is equally certain that it is not generically identical with the forms originally placed under *Bulimella*, as it has not the truncated columella characteristic of that genus. To be sure Capt. Portlock states in his remarks upon that species that "in some specimens it [the columella] has evidently been truncated." This does not prove it to be a generic feature of his *P. elongatus*, but only shows that he confounded two distinct species in description, while figuring only one. Messrs. M. & W. have also fallen into a similar error in placing shells of two entirely distinct genera under *Polyphemopsis*, *P. peracuta* being a true *Polyphemopsis* according to the features shown in Portlock's figures, while *P. inornata* and *P. nitidula* both belong to *Bulimella*.

Taking into consideration these facts, I propose to substitute for the name *Bulimella* given by Prof. Hall that of BULIMORPHA, and to retain the group as a valid genus.

BULIMORPHA, n. g.

Shell fusiform, spire produced; volutions convex, the last large; columella bent and truncated at the base, where it is separated from the outer lip by a notch as in the recent genus *Achatina*; outer lip very slightly notched near the upper end; surface of the shell smooth. Type *B. bulimiformis*, Hall.

Bulimorpha bulimiformis (*Bulimella bulimiformis*, Hall; *Trans. Alb. Inst., Vol. 4, p. 29;—Polyphemopsis bulimiformis*, (Hall) *M. & W., Geol. Rept. Ills., Vol. 2, p.* 372.) **Plate 8, Figs. 37-39.**

"Shell fusiform, elongate; spire nearly equal to half the length of the entire shell; volutions about six, slightly convex in the middle, increasing somewhat rapidly, the last one equaling in length all the others; aperture elongate-oval, acute at each extremity, slightly sinuate at the upper outer angle; columella slightly curved, and truncate at the base; surface smooth or with faint lines of growth.

"Length .25 to .75 of an inch."

This species is the most common one occurring in these beds, and will be found to vary greatly in the proportional length and thickness as well as somewhat in the ventricosity of the volutions.

Localities.—Spergen Hill and Bloomington, Ind.

Bulimorpha canaliculata (*Bulimella canaliculata*, Hall; *Trans. Alb. Inst., Vol. 4, p. 29;—Polyphemopsis canaliculata*, (Hall) *M. & W., Geol. Rept., Ills., Vol. 2, p.* 372.) **Plate 8, Fig. 41.**

"Shell sub-fusiform; somewhat elongate; spire short, scarcely equaling the length of the last volution; volutions about five, upper ones scarcely convex, rapidly diminishing to the apex, last volution longer than the spire above, slightly ventricose; suture canaliculate, the groove margined by a slight sharp carination at

the upper edge of the volution; aperture sub-ovate; surface smooth, or marked with fine lines of growth which are abruptly bent backwards at the carination on the upper edge of the volution which marks the notch in the upper angle of the aperture.
"Length .18 of an inch."

The notch mentioned in the above description is not a notch in the lip like that of *Pleurotomaria*, *Murchisonia*, &c., but is formed by the channeling of the suture only. This feature at once distinguishes this from any of the other species described.

Locality.—Spergen Hill, Ind. The locality as given under the original description includes Bloomington, Ind. also. Only one characteristic specimen exists in the collection, that being from Spergen Hill, Ind.

Bulimorpha elongata (*Bulimella elongata*, Hall; *Trans. Alb. Inst., Vol.* 4, *p.* 30;—*Polyphemopsis elongata*, (Hall) *M. & W., Geol. Rept., Ills., Vol.* 2, *p.* 372. *Polyphemopsis teretiformis*, Hall; *Cat. Am. Pal. Foss., S. A. Miller, p.* 245.) **Plate 8, Fig. 40.**

"Shell extremely elongate; volutions seven or eight (perhaps nine), somewhat rapidly ascending, moderately convex, the greatest convexity a little above the middle, last one slightly ventricose; suture distinct, an undefined angular elevation below, corresponding to the notch in the lip; surface nearly smooth; direction of the striæ scarcely visible.
"Length .50 of an inch."

The undefined angular elevation below the suture mentioned in the description is remarkably obscure in the type specimen, and corresponds only to the "greatest convexity" which exists "a little above the middle" of the volutions. The species is very rare, nearly as much so as *B. canaliculata*, only the type specimen being found in good condition; a few other worn specimens only having been observed. The change of generic name will restore the original specific name of *elongata*, making it BULIMORPHA ELONGATA, Hall's sp.

Locality.—Spergen Hill, Ind.

Genus CYCLONEMA, *Hall.*

Cyclonema Leavenworthana (*Pleurotomaria Leavenworthana*, Hall; *Trans. Alb. Inst., Vol.* 4, *p.* 24.) **Plate 8, Figs. 29-31.**

"Shell ranging in form from sub-globose to terete-conical and elongate-ovate; spire conical, varying greatly in its elevation from the young to the old shell; volutions five to seven, neatly rounded and ventricose below; suture well defined; aperture round-oval; umbilicus none; surface marked by conspicuous, rounded, revolving striæ, which are less than the spaces between; striæ less conspicuous on the base of the last volution; the first line below the suture uniformly thinner and sharper than the others, and the spaces on each side wider.

"Length from .05 to .50 of an inch."

This shell is remarkably variable in the degree of expansion of the volution, the apical angle being in some cases nearly twice as great as in others, while the increase of the volution is equally variable. These changes give one the impression, when only a few individuals are examined, that there are two distinct species represented; but so many connecting forms can easily be obtained, that one soon abandons this view. The species presents no evidence of being a true *Pleurotomaria*, as there is no indication of a notch between any of the revolving striæ. The characters correspond much more nearly to those of *Cyclonema*, Hall, although it lacks the flattening of the columella that is seen in *C. bilix*.

Localities.—Spergen Hill and Bloomington, Ind., and Alton, Ill.

Cyclonema subangulatum (*Pleurotomaria subangulata*, Hall; *Trans. Alb. Inst., Vol.* 4, *p.* 25.) **Plate 8, Fig. 32.**

"Shell ovate-conical; volutions about five or six, angular above, the last one ventricose below; upper side of volution nearly rectangular to the direction of the spire; aperture ovate, the inner side straight or concave; umbilicus none; suture distinct; surface ornamented by unequal, revolving lines, those on the lower part of the last volution finer and more closely arranged, three of those on the periphery stronger and more distant, the upper one of these three stronger than the other two, forming the summit of the angle; midway between the angle and the suture is one strong angular striæ, and on the outer side, and sometimes on the inner side of this a finer one.

"Length .35 of an inch."

This shell is closely allied to *C. Leavenworthana*, and will most likely prove to be only a variety of that one. The carinated upper angle of the last volution is caused by the dropping out of the revolving line below it, and to some extent also that above, causing this individual line to stand out more prominently. In the form of the lower part of the volution and in that of the aperture, they agree perfectly.

Locality.—Spergen Hill, Ind.

Genus LOXONEMA, *Phillips.*

Loxonema Yandelliana, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 28.) **Plate 8, Figs. 35 and 36.**

"Shell terete-subulate; spire elongate, very gradually tapering to the apex, which is apparently obtuse; volutions about eight or nine, very little convex, the last one scarcely expanded; suture distinct; surface marked by fine thread-like striæ crossing the volutions with a slight undulation above the middle; aperture ovate.

"Length .20 to .50 of an inch."

This species has proved to be exceedingly rare, and so far as seen is usually quite small. The fragment figured represents the largest growth yet noticed, while the surface markings are much stronger proportionally than on any other specimen examined.

Locality.—Spergen Hill, Ind.

Loxonema vincta, see **Murchisonia vincta.**

The shell described in the original Spergen Hill paper as *Pleurotomaria concava* presents features entirely incompatible with those of any known genus so far as I can ascertain. It is trochiform, being broadly conical above and flattened or concave below, with a wide umbilicus extending to the nucleus of the spire, as in Solarium. The aperture is very oblique, and the periphery of the volutions is extended in form of a thin flange under which the succeeding volution is formed. No apertural slit exists, nor are the striæ of growth interrupted at the periphery, except when the expansion is broken off. The surface ornamentation consists of simple lines of growth above, while below the flattened surface is marked by revolving lines. For this and similar species I propose the generic name EOTROCHUS.

EOTROCHUS, N. Genus.

Shell conical above, flat or concave beneath, and broadly and deeply umbilicated. Aperture very oblique, and the outer angle of volutions strongly carinated or expanded. Surface ornamentation unlike on the upper and lower surfaces. Type E, CONCAVA *Pleurotomaria concava*, Hall.

The genus differs from the umbilicated forms of the Trochidæ in not having the inner or umbilical surface of the volution distinct from the basal parts, (*i. e.* not forming a columella), but the lower or basal surface of the volution slopes gradually and smoothly into, and forms the sides of the umbilicus, giving an obliquely elliptical section to the volution. From the forms usually placed under *Onustus*, Humph. it differs but little except in the character of growth, and surface of the lower side of the volutions. So far as known, it forms no peripheral digitations or ornamentation as in that genus. In the Pal. Rept. of Ohio, Vol. 1, p. 221, Mr. F. B. Meek proposes the name *Pseudophorus* for a group of shells which he referred with doubt to *Xenophora*, Fischer, but which he does not characterize. The shell for which he proposed it, however, differs widely in character from the one under consideration; it being imperforate, although having a broad umbilical depression, and the lower surface of the shell is a direct continuation of the upper surface like the volution of *Platyostoma* or *Natica*, only being angulated on the periphery; while this one possesses a distinct system of growth and surface markings. This with the open umbilicus is sufficient to distinguish it as a separate generic group, the Ohio shell being only a flattened *Platyostoma*.

Eotrochus concavus, (*Pleurotomaria concava*, Hall; *Trans. Alb. Inst., Vol. 4, p. 24—P. tenuimarginata*, Hall: *Cat. Am. Pal. Foss.*, S. A. Miller, p. 245.) **Plate 9, Figs. 21-23.**

"Shell trochiform; spire depressed-conical; volutions about five, flattened or slightly concave above; base of shell concave; periphery alate, alation curving downwards at the margin; aperture transversely ovate (the wider part at the pillar); umbilicus medium size, round; suture linear, rather indistinct; surface smooth or marked by obsolescent striæ, which turn abruptly backwards from the suture to the periphery; similar striæ are sometimes visible on the base of the shell, bending abruptly backwards on the alation.

"Diameter .25 to .75 of an inch; height from .20 to near .50 of an inch."

The original specimens of this species were so very poor that they seem to have led to some misconceptions of characters. On

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clearing away the rock from the base of some of the larger specimens, the surface of this part is seen to be marked by about thirteen flattened revolving lines, and with the strongest hand glass no oblique lines resembling those on the upper surface can be seen, although the apparent receding of the lower lip of the aperture would give this direction. The "pillar" spoken of in describing the form of aperture, should not be interpreted as indicating a solid columella, but only the wall of the open umbilicus. The largest specimen in the collection has a diameter of considerably more than one inch.

Localities.—Spergen Hill, Ind., and Alton, Ill. No individual from Bloomington is present in the collection.

Genus PLEUROTOMARIA, *D. France.*

Pleurotomaria subglobosa, Hall; (*Cat. Am. Pal. Foss.*, S. A. Miller, p. 245. *P. rotundata*, Hall, *Trans. Alb. Inst.*, *Vol.* 4, *p.* 23.) **Plate 9, Fig. 10.**

"Shell sub-globose; volutions about five or six, convex, the last one very rotund or ventricose; suture distinctly marked, and the volution depressed just below it, and rising in an obtuse, undefined angle, below which is a distinct depressed revolving line, and below this again a similar sub-angular elevation, which forms the upper limit of the broad periphery of the outer volution; thus making the upper side of the volution obscurely biangular with one depression between the angles, and the other towards the suture. [These angles and the depression between are distinctly visible in the cast.] Aperture broadly ovate; umbilicus small; surface marked by fine, closely arranged revolving striæ.

"Diameter .09 to .45; height .04 to .38 of an inch."

On the larger individuals of this species, the volutions are entirely round above and on the sides, completely destroying the subangulations spoken of in the description, the depressed band being most distinct in the small and medium sized individuals. But the term "biangular," is perhaps, too marked to apply to so round and globular a shell. The umbilicus is very distinct when clear of adhering rock, and its margin abrupt. On very well preserved specimens the under side is seen to be marked by very fine revolving lines, but those on the upper side of the volutions only are visible on most examples.

Localities.—Spergen Hill and Bloomington, Ind., and Alton, Ill.

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Pleurotomaria Swallovana, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 24.) **Plate 9, Figs. 1 and 2.**

"Shell depressed, somewhat globose, spire little elevated; volutions about five, regularly rounded, the last one sub-ventricose, and sometimes a little more expanded at the periphery; suture well defined; aperture sub-circular, a little oblique on the pillar; umbilicus large, circular; a flattened band upon the periphery of the shell margined on each side by a distinct elevated line; volutions crossed by fine, even, thread-like striæ which are smaller than the spaces between them, more conspicuous on the upper side of the volutions and often obsolete on the lower side.

"Diameter .12 to .25; height .07 to .20 of an inch."

The general resemblance of this species is somewhat similar to that of *P. subglobosa,* but it is much more depressed, although very variable is this respect. The transverse striæ on the upper surface of the volution, and the situation of the band which is on the periphery in this case will serve to distinguish this species.

Localities.—Spergen Hill and Bloomington, Ind.

Pleurotomaria trilineata, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 25.) **Plate 9, Fig. 20.**

"Shell ovate-conical; spire more or less elevated, acute at the apex; volutions about six, convex, last volution ventricose; suture distinctly defined; aperture sub-circular; columella perforate by a small umbilicus; surface marked upon the periphery by a comparatively broad spiral band, which is margined on each side by a linear groove; two other similar grooves between the band and the umbilicus, dividing the base of the shell into three spaces, each one equaling in width the spiral band; entire surface, except the spiral band, ornamented by revolving, thread-like striæ, which are crossed by fine lines of growth, the latter becoming stronger and curving slightly backward upon the spiral band; an almost imperceptible angulation just below the umbilicus.

"Length .125 to .50 of an inch."

The measurement ".125" as given in the original paper is probably a misprint and should be .25. The largest specimen which I have observed is about .75 of an inch high.

Localities.—Spergen Hill and Bloomington, Ind., and Alton, Ill.

Pleurotomaria nodulostriata, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 21.) **Plate 9, Fig. 5.**

"Shell turbinate; spire depressed-conical, obtuse at the apex;

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volutions about four, rounded, somewhat depressed above, the last one ventricose below; suture distinct, rather sharply defined; aperture sub-circular, slightly flattened on the inner side; umbilicus rudimentary; surface marked by strong, revolving elevated striæ which are about equal to the spaces between them, excepting on the periphery of the outer volution where two or three are more distant, leaving a double spiral band; revolving striæ crossed by oblique striæ (parallel to the lines of growth) which are very conspicuous on the upper side of the volution, but become obsolete below the band. The revolving lines at the junction of the oblique striæ become nodulose on the upper half of the volution, and particularly near the suture.

"Diameter .12 to .18; height .10 to .18 of an inch."

In most of the specimens, especially the larger ones, the upper side of the volution is obliquely flattened in the direction of the apical angle, and the periphery vertically flattened. They vary greatly in the rate of increase, the apical angle varying from less than sixty to about ninety degrees in different specimens. There are apparently two strong varieties included among those referred to the species, one having coarse revolving lines on the lower side, the other marked by very fine lines, the latter having a very depressed spire and flattened periphery; though I think there are intermediate forms enough to unite them.

Localities.—Spergen Hill and Bloomington, Ind., and Alton, Ill.

Pleurotomaria Worthenl, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 23;—*Geol. Rept., Iowa,* 1858, *p.* 530, *Pl.* 23, *fig.* 13.) **Plate 9, Fig. 4.**

"Shell depressed sub-globose; spire but little elevated, oblique from the great expansion of the last volution; volutions about three, somewhat flattened above, rapidly expanding, so that the last volution makes nearly the whole bulk of the shell; obtusely angulate on the periphery; upper margin of the volutions marked by a row of strong nodes, which extend about one-third across; surface marked above by striæ parallel to the lines of growth which on the last volution disappear in passing over the angulate periphery; base of last volution marked by strong revolving lines on the space between the outer margin and the umbilical area; base deeply excavated about the umbilical region, but the umbilicus is unknown. Aperture sub-quadrate, upper edge of the outer lip projecting far over the lower.

Diameter .60; height .48 of an inch."

This shell is not a very characteristic form of *Pleurotomaria.* 1882.]

In fact it approaches much nearer to the genus CRYPTÆNIA, Deslonch, Mem. Soc. Lin., Vol. VIII, p. 147, than to the true *Pleurotomaria*, as the slit in the periphery has been very obscure and concealed by the succeeding volutions. The form is also depressed and the aperture very oblique, receding very much on the lower side. I have not been able to ascertain the form of the umbilicus in *Cryptænia*, but in this species the depression is very broad and patulose, although the real perforation itself is very small indeed. The row of nodes mentioned in the description as characterizing the upper side of the volution, have the form of undulations of this part of the shell, are somewhat oblique and only pertain to the last one or one and a half volutions. The surface of the shell when not worn is covered by revolving lines both above and below, except within the umbilical depression, the very margin of this only being marked.

Localities.—Spergen Hill and Bloomington, Ind.

Pleurotomaria humilis, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 21.) **Plate 9, Fig. 3.**

"Shell depressed, trochiform, oblique, spire little elevated, consisting of three or four volutions which increase rapidly in size from the apex; volutions depressed-convex above, and declining to the periphery; base of the last volution less convex than on the upper side, sub-obtusely angular on the periphery which is marked by a narrow groove, little wider than the usual spaces between the revolving striæ; surface marked by revolving and transverse striæ which are stronger and more distant on the upper side of the volution, giving it a beautiful cancellated appearance; while they are closer and finer on the lower side of the shell; mouth transversely oval; umbilicus small.

"Diameter .10 to .19; height .07 to .14 of an inch."

The specimens upon which this species was founded, and of which the above is the description, are only the young shells of PLEUROTOMARIA WORTHENI, Hall, and their locality the same as of that species.

Pleurotomaria (?) Meekana, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 22.) **Plate 9, Figs. 8 and 9.**

"Shell depressed-conical; spire short, rapidly diminishing and obtuse at the apex; volutions about five, appressed above and sub-angular below, with the periphery vertical; suture distinct;

last volution large, not ventricose, biangular on the periphery, with a defined groove in the centre which is distinctly margined above and below by an elevated line; surface on the upper side of the volutions marked by revolving and transverse striæ of equal strength, which are regularly cancellated, (and when not worn there is a slight nodosity at the crossing). The revolving lines on the base of the last volution are closer and finer than those above, and equally, but less distinctly, crossed by the transverse lines which make a deep sinuosity on the periphery of the shell. Aperture sub-quadrate, with a deep notch in the outer margin at the termination of the revolving band; umbilicus of medium size.

"Diameter .18; height .13 of an inch."

The species is represented in the collection by only a single imperfect specimen, on which the characters are rather obscure. It has more the form of a *Trochonema* than of a *Pleurotomaria* in the general form of the shell and spire. There is but very indistinct evidence of the "deep notch" in the outer margin of the shell, and I cannot detect any revolving lines on the lower side of the last volution as stated.

Locality.—In the original paper the locality is given as Spergen Hill, but the card is marked Alton, and the specimen shows the lithological characters of the rock from that locality. Therefore I think it probable the locality has been wrongly stated by mistake.

Pleurotomaria Piasaensis, Hall; (*Trans. Alb. Inst., Vol. 4, p. 22.*) **Plate 9, Figs. 6 and 7.**

"Shell depressed, sub-globose; spire short and little elevated, consisting of about four volutions; volutions rapidly increasing in size, depressed-convex above, somewhat rounded below, and becoming sub-angular near the aperture; the periphery abruptly rounded and marked by a spiral groove or band; surface marked by about four strong spiral or revolving striæ on the upper side of the volution, between the periphery and suture, and four or five similar striæ on the lower side; transverse striæ scarcely distinct except in the spaces between the revolving striæ; umbilical depression rather broad, and margined by a strong angular elevation towards the aperture of the shell; aperture sub-quadrangular, the pillar side shorter; the outer side, from the periphery to the angle bordering the umbilical region, nearly straight, and equal to the space from the periphery to the suture.

"Diameter .17; height .10 to .11 of an inch."

The shells of this species are very variable in the form of the volutions; some being round on the periphery, and others quite angular, that figured being of the latter group. Of course this sharpness on the edge gives a more obliquely flattened form to the upper and lower surface, destroying to a considerable extent the "sub-globose" form as mentioned in the original description. The number of bands and the strength of the transverse striæ also vary. On the angular specimens there is often a carinated band forming the margin, when it becomes difficult to distinguish the position of the slit which should characterize the genus to which it is referred.

Locality.—Piasa Creek, above Alton, Ill., the locality of the Alton bed.

Pleurotomaria conula, Hall; (*Pleurot,* (*Murchisonia ?*) *Conula,* Hall; *Trans. Alb. Inst., Vol.* 4, *p.* 26.) **Plate 9, Fig. 17.**

"Shell conical, spire gradually and uniformly diminishing from the base; volutions six to eight, angular in the middle, and flattened above and below; sutures defined; surface marked by distinct, elevated, nearly vertical striæ both above and below the spiral band; spiral band occupying the periphery of the volution, and composed of three revolving minute carinations with narrow depressions between (sometimes only two elevated bands are visible); aperture sub-quadrate; columella extended below, perforate.
"Length from .08 to .18 of an inch."

The generic relations of this shell are rather obscure, as it seems to be intermediate between *Murchisonia* and *Pleurotomaria.* If it were not perforated it would form a very good *Murchisonia,* but the type of that genus has a solid axis, and all true species of the genus in the Devonian have, while this species is very distinctly umbilicated. The slit in the aperture is very narrow, and in the specimen figured is seen to be open for nearly an entire volution, becoming gradually narrower as it recedes from the aperture, and in closing finally forms the third carination of the band mentioned in the description.

Locality.—Spergen Hill, Ind.

Pleurotomaria elegantula, Hall sp.; (*Murchisonia elegantula,* Hall; *Trans. Alb. Inst., Vol.* 4, *p.* 27—*Pleurotomaria Shumardi, M. and W.; Geol. Surv. Ill., Vol.* 2, *p.* 260, *Pl.* 18, *fig.* 6.) **Plate 9, Fig. 19.**

As the original description of this species was taken from a very imperfect and immature specimen it is very incomplete, and I have thought best to substitute that given by Messrs. Meek & Worthen, *loc. cit.* which is much better. The shell is a very good *Pleurotomaria*, and does not in its complete form possess the features of the genus *Murchisonia.*

"Shell trochiform, of medium size, very thin ; spire moderately elevated, conical, somewhat attenuate at the apex. Volutions about seven, increasing rather rapidly in size, obliquely flattened above ; those of the spire somewhat angular near the lower side ; last one very prominent, and angular around the middle, moderately convex below, the immediate edge of the angle being truncated by the narrow spiral band. Band flat or slightly concave, and margined above and below by a small, smooth, slightly elevated line; passing around a little above the suture on the whorls of the spire. Suture well defined; umbilicus small; aperture rhombic-sub-quadrate, wider than high. Surface ornamented by numerous transverse lines, which are very regular and closely arranged on the upper whorls, but become stronger, more distant, and less regular on the last turn. In crossing the upper, flattened, sloping sides of the whorls, these lines arch a little forward, and pass very obliquely backwards from the suture to the band; on the under side of the body whorl, they are smaller or nearly obsolete, and crossed by obscure traces of fine revolving striæ. Length 0.70 inch, breadth 0.73 inch ; apical angle rather distinctly concave ; divergence 0.70."

Localities.—Bloomington, Ind., and Warsaw, Ill.

Genus MURCHISONIA, *D'Arch. & Vern.*

Murchisonia insculpta, Hall ; (*Trans. Alb. Inst., Vol.* 4, *p.* 26.) **Plate 9, Fig. 18.**

"Shell subulate-conical; spire somewhat rapidly ascending, acute; volutions six or seven, convex and rounded in the middle, appressed and sloping gradually above, and abruptly below, to the suture; upper side of volutions marked by vertical elongate nodes, which are pointed above and gradually disappear in the surface below, or subdivide into distinct elevated striæ; spiral band rather broad, margined by two distinct elevated lines with the intermediate space convex or concave; last volution ventricose, extended below, and marked by an elevated line which is a continuation of the suture line; aperture somewhat rounded, and extended in front; columella extended below and imperforate.

"Length from .05 to .25 of an inch."

The species approaches more nearly to *Pleurotomaria conula*

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than to any other associated species, but can be readily distinguished by the more highly conical form, coarser markings, more extended aperture, more ventricose last volution which is longer on the lower side, and by not being umbilicated. The slit in the last volution extends from the margin of the aperture backwards for about one-fourth to one-third of a volution.

Localities.—Spergen Hill and Bloomington, Ind.

Murchisonia terebriformis, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 28.) **Plate 9, Figs. 15 and 16.**

"Shell extremely elongate, subulate-acute; volutions eight or nine, very convex, marked by a broad spiral band in the centre, last volution ventricose; suture deeply marked; surface ornamented on the upper side of the volutions by fine striæ, which extend obliquely backwards to the spiral band, below the band by one or two spiral elevated striæ, and on the last volution by four or five similar striæ; aperture unknown; umbilicus none.

"Length .33 of an inch."

This shell resembles in its general features *Pleurotomaria trilineata*, Hall, herein described, but is more elevated than the most slender forms of that species, and has a less ventricose volution as well as a greater number of whorls. The surface ornamentation is quite distinct as there are none of the fine revolving lines above the band on this one, the surface being marked by transverse striæ only, and the revolving lines below are raised, flattened, narrow bands instead of impressed lines as on that one. The shell is also imperforate.

Locality.—Bloomington, Ind.

Murchisonia vincta, (*Loxonema vincta*, Hall; *Trans. Alb. Inst., Vol.* 4, *p.* 28.) **Plate 9, Fig. 14.**

"Shell extremely elongate, very gradually tapering from the base; volutions convex below, appressed above, banded just below the suture, and marked by transverse arching striæ; aperture ovate, wider below; umbilicus none.

"Length one inch."

The description given of this species is very incomplete, and the specimens are usually too imperfect to afford means for better. The volutions have been as much as ten or twelve in number, are very little convex, the upper half being depressed from the presence of a broad concave band just above the centre, which gives them an obliquely flattened character, and throws the greatest convexity below the middle; often causing a slight angularity, and leaving a narrow flattened band below the suture line above the band. This form is so common a feature of the genus *Loxonema*, that it is very natural to make the wrong generic reference, especially as the surface markings are extremely fine and often obsolete. In the type specimen, however, they can be seen with a good glass, and show a decided recurving in crossing the depressed band, showing decidedly its generic affinities with *Murchisonia*. It is the largest shell of the form found in these beds, and is readily distinguished from any of the non-lirated species by its more slender form, and from those by its greater size and smooth volutions.

Locality.—All the specimens yet observed have been from Spergen Hill, Ind.

Murchisonia vermicula, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 27.) **Plate 9, Fig. 11.**

"Shell cylindrical, abruptly tapering at the apex; volutions from six to ten, moderately convex in the middle, and scarcely diminishing for the first four or five turns above the base, but becoming more abruptly contracted above; surface of each volution marked by two very prominent revolving striæ, having a space between them on the periphery, and a single finer line below and one above near the suture; the last volution not ventricose, and marked by a fifth revolving striation, which is a continuation of the suture line; aperture broadly oval, rounded below; columella imperforate. Shell minute.

"Length .14 of an inch."

This is the smallest gasteropod found in the Spergen Hill beds, and is extremely abundant in certain layers. The shell is nearly cylindrical for more than half its length in the larger specimens, the increase being mostly in the upper four or five volutions. The spiral bands are often nearly obsolete, or the upper and lower are indistinct, and the central ones very strongly marked. It is readily distinguished from the apical portion of *M. turritella* by its cylindrical form, that one being regularly tapering.

Localities.—Spergen Hill and Bloomington, Ind.

Murchisonia turritella, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 27.) **Plate 9, Fig. 12.**

"Shell subulate, elongate, gradually tapering to the apex; suture distinct; volutions about nine; equally rounded, the last one slightly ventricose; surface marked by closely arranged, rounded, revolving striæ, which are stronger on the middle of the volution; five revolving striæ on each volution of the spire, and about seven on the last volution; aperture sub-ovate; columella slightly extended, and curved around the aperture, imperforate.

"Length .18 to .50 of an inch."

The shells of this species are very variable in their rate of increase and in the comparative height of the volutions, as also in the strength of the revolving lines. These latter are often quite sharp or angular, or others are rounded as stated in the description above. The band marking the slit in the lip is situated above the middle of the volution, and is not well marked until the shell attains considerable size, when it becomes distinct. This feature gives a central or sub-central line, so that there are five lines exposed on each volution. There is but one associated species with which it will be readily confounded, namely, *M. attenuata*, under which species comparisons will be found.

Locality.—Spergen Hill, Ind.

Murchisonia attenuata, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 27.) **Plate 9, Fig. 13.**

"Shell subulate, elongate; spire very gradually tapering; volutions nine or more, flattened, scarcely convex in the middle, and marked by a spiral band which is margined on either side by a strong elevated line; suture bounded on each side by a sharp elevated line which is smaller than those bordering the spiral band; aperture transverse; umbilicus none."

There will always be considerable difficulty in distinguishing between this one and *M. turritella*, more especially so as no perfect specimens of this have been observed, so that the entire characters are unknown. It is probably a distinct species, but the only distinction that remains constant, even among the small number of individuals observed, (some five) consists of the number of revolving lines, which on this one is four, and on that five. As a pretty general thing they are sharper on this form, and those near the suture line less distinctly so than those bordering the band. This feature destroys that roundness of the volutions so characteristic of *M. turritella*. The band is also situated nearer the middle of the volution, and the shell is perhaps a little more slender.

Locality—Spergen Hill, Ind.

HETEROPODA.

Genus BELLEROPHON, *Montf.*

Bellerophon sublævis, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 32;—*Geol. Iowa,* 1858, *p.* 666, *Pl.* 23, *fig.* 15.) **Plate 8, Figs. 6 and 7.**

"Shell sub-globose, inflated on the last volution; aperture transverse, arcuate, expanded, the lip thickened and much extended at the junction with the volution; umbilicus none; dorsum carinated by a narrow slightly elevated carina; surface ornamented by fine, regular striæ which bend abruptly and deeply backwards on the carina, denoting the depth of the emargination of the lip; striæ sometimes irregular from interrupted growth.

"Length from .062 to .875 of an inch."

This shell belongs to the non-umbilicated section of the genus, and in the adult shell the lip is much thickened over the umbilical area, so as to form a strong callus; while in the younger stages it is but slightly thickened, or in the very young is thin and scarcely enrolled. The volutions are strongly embracing, the last one so much so as to give a deeply reniform aperture. The dorsal keel is but slightly marked and very narrow, and in very many of the larger individuals becomes entirely obsolete, either from an external deposit or from a kind of erosion which has taken place before the shells were finally imbedded, and which has also obliterated the surface markings. Besides the broad emargination of the lip indicated by the transverse lines of growth, they sometimes show a deep slit of the width of the dorsal band extending an eighth of an inch or more from the margin of the lip. There is no described species from the lower carboniferous formations that approaches very near this one; *B. Stevensianus*, McChes., Pal. Foss. Pl. 2, fig. 18, from the coal measures of Illinois and the west, is as near as any, but is compressed laterally, more strongly marked and more distinctly carinate. Specimens measuring an inch and one-eighth have been more recently obtained at Spergen Hill, and at Ellettsville, Ind.

Localities.—Spergen Hill, Bloomington, Paynter's Hill, and Ellettsville, Ind., and Alton, Ill.

Bellerophon textilis, Hall; (*Bellerophon textilis*, Hall; *Cat. Pal. Foss.* S. A. Miller, 1877;—*B. cancellatus*, Hall; *Trans. Alb. Inst., Vol.* 4, *p.* 31.) **Plate 8, Figs. 4 and 5.**

"Shell sub-globose; aperture transversely oval, arcuate, with the lip reflexed at the sides; umbilicus small in young shells, and scarcely visible in the older specimens from the thickening of the lip; surface marked by fine longitudinal elevated striæ, of which about thirty may be counted on each side of the carina, increasing by implantation with the age of the shell; carina rather narrow and little elevated, very indistinctly marked by the longitudinal striæ. Transverse striæ in the direction of the lines of growth, irregular, sub-imbricate, more distant than the longitudinal striæ, bending backwards on the carina. At the crossing of the two sets of striæ the surface is slightly nodulose, in well preserved specimens.

"Length .125 to .75 of an inch or more."

This is the only cancellated form described from the carboniferous rocks of the Western States, and is a form more characteristic of the Devonian and Waverly formations than of this horizon. The shells which I have seen all have the appearance of immaturity, and there is an uncertainty as to whether the lip may or may not have been reflected in the adult stages, like those of the same type in the lower formations mentioned. If it were thin and unreflected as in the specimens known, this alone would be a distinguishing mark. But the even cancellation of the surface otherwise distinguishes it from all except *B. Leda*, Hall, from the Hamilton shales of New York, which always has a broader band, and is rather more decidedly umbilicate.

Localities.—Spergen Hill and Bloomington, Ind.

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PTEROPODA.

Genus CONULARIA, *Miller.*

Conularia subulata, Hall ; (*Trans. Alb. Inst., Vol.* 4, *p.* 32.) **Plate 8, Fig. 3.**

"Shell quadrangular, the four sides nearly flat and converging at an angle of about 18° ; surface marked with a distinct longitudinal groove on each of the angles, and numerous regular, smooth, closely arranged, elevated, transverse striæ, which pass a little obliquely downwards towards the middle of each of the sides, where they meet at a very obtuse angle. A single sharp longitudinal line passes down the centre of each side, without interrupting the transverse striæ ; angles truncate or rounded towards the apex.

"Length .50 of an inch."

The striæ on this shell, so far as can be determined from the imperfect specimens in the collection are smooth, and have had no longitudinal striæ crossing them, cutting their surfaces into ornaments as is generally the case in this genus. They are very angular and occupy the entire space of the furrow. The number in a given distance varies with the distance from the apex of the shell, one counting eighteen in a tenth of an inch where the shell measures a twelfth of an inch in diameter, and another where the shell is a trifle less than a sixth of an inch in diamter there are only ten in the same distance. The specimens are too small and imperfect to afford means for comparison with other described forms.

Locality.—Alton, Ill.

CEPHALOPODA.

Genus ORTHOCERAS, *Breyn.*

Orthoceras epigrus, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 33.) **Plate 8, Fig. 2.**

"Shell sub-cylindrical, very gradually tapering ; section circular ; siphuncle small, sub-central ; septa slightly concave, separated by spaces equal to about one-third the diameter of the shell ; surface marked by distant, rather faint, longitudinal lines."

The only specimen of the species in the collection is a fragment retaining five chambers. The septa are remarkably flat. With a strong hand glass I fail to find any indications of the "rather

faint longitudinal lines" spoken of in the original description.
Locality.—Spergen Hill, Ind.

Genus NAUTILUS, *Breynius.*

Nautilus Clarkanus, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 32.) **Plate 8, Fig. 1.**

"Shell sub-discoidal, flattened on the dorsum, and angular at its lateral margin; umbilicus large, showing all the inner volutions; volutions (number unknown) rapidly diminishing, broader than high, not embracing; surface ornamented by a deep revolving groove round the dorso-lateral margin, between which and the umbilicus is a single row of indistinct nodes, and about five or six strong striæ, which are crossed by fine elevated striæ. Aperture transversely oval; septæ slightly concave, and separated by spaces about equal to one-fourth the greater diameter of the volutions.

"The specimen described is somewhat worn upon the dorsal side, which may have obliterated the fine transverse or longitudinal striæ, remaining upon the lateral edge of the shell."

The specimen used for the above description is a fragment of what was a much larger shell, and from its imperfect condition has led to a misconception of the characters of the species. There are three small fragments in the collection which show that the volutions were not flattened on the dorsum, but that portion which forms the flat surface, and the border of the "deep revolving groove round the dorso-lateral margin" of the volution, is only a portion of the inner surface of a succeeding volution which has been broken away, leaving the ventral portion attached to the present one. The dorsal surface has been broadly convex, and so far as seen on the fragments mentioned has been marked by revolving ridges, coarser and more distant than on the side of the volution. None of the specimens show the position of the siphon or afford means of comparison with other species.

Locality.—Spergen Hill, Ind.

ANNELIDA.

Genus SPIRORBIS, *Lamarck.*

Spirorbis annulatus, Hall; (*Trans. Alb. Inst., Vol.* 4, *p.* 34.) **Plate 9, Fig. 30.**

"Shell planorbicular, more or less ascending, irregularly spiral; spire composed of about three turns, which are contiguous or more or less disconnected ; umbilical side more or less deep and regular according to the regularity of the spiral; surface ornamented with strong annulations, with finer striæ between.

"Diameter from .062 .25 of an inch."

This species attains a rather larger size than is common with those of the genus. The coiling of the tube is very irregular, but is always dextrally ascending from a small base of attachment, although the specimens are invariably found free. The annulating striæ are strong, raised and lamellose, and form a very good distinguishing feature of the species.

Localities.—Spergen Hill and Bloomington, Ind., and at Alton, Ill.

Spirorbis nodulosus (*Spirorbis annulatus*, var. *nodulosus*, Hall; *Trans. Alb. Inst.*, *Vol.* 4, *p.* 34.) **Plate 9, Fig. 31.**

"Shell in form like the preceding; last volution strongly deflected ; volutions sub-angular, marked by oblique striæ or ridges which become strongly nodulose on the umbilical side, and particularly towards the aperture."

The nodose character of this species is a strong distinguishing feature, and is entirely unlike the surface structure of the preceding one, being composed of oblique rows of thickened nodes, not capable of being formed by a modification of the distant, straight, encircling lines of the surface of that one, therefore I see no impropriety in classing it as a distinct species. It possesses about two or two and a half volutions, the latter part of the outer one being deflected to nearly an upright position and is free and cylindrical. Both these species in nearly every case show evidence of having been fixed to some foreign substance when living and young, but are always, so far as I am aware, found loose in the rock. It would seem probable that they had been attached during life to some perishable substance, as a plant, which on decomposing had freed the tubes and allowed them to fall to the bottom of the water in a free state

Locality.—Spergen Hill Ind.

OSTRACODA.

Genus LEPERDITIA, *Rouault.*

Leperditia carbonaria (*Cythere* carbonaria*, Hall; *Trans. Alb. Inst., Vol.* 4, *p.* 33.) **Plate 9, Figs. 24-27.**

"Shell oval or sub-ovate, gibbous; slightly compressed towards the margins; ventral [dorsal] margin straight, one-third less than the greatest length of the valves; extremities rounded, broader anteriorly; dorsal [ventral] margin forming a broad curve; surface smooth.

"This species does not exceed a single line in length. Compare with C. PUSILLA, McCoy."

The carapace of this species is broadly ovate, slightly narrowed anteriorly; hinge-line straight about half as long as the valves, which are compressed towards the dorsal line and become rapidly inflated toward the ventral; extremities of the hinge angular, so as to produce a slight feature at this point. Right valve considerably larger than the left, and overlaping it except on the dorsal margin, at which point the left projects above the right. Ocular spot not definitely determined. There is a small tubercle present on some individuals just behind or at the middle of the length, on the right valve, indicated on the figure, but which is very obscure and rarely seen. On the casts at this point a circular scar is also visible on each side, indicating the position of the muscular tubercle, but no evidence of the ocular tubercle has been observed. In the original description above quoted the terms dorsal and ventral are used reversed; the corrections in brackets are now added.

Localities.—Spergen Hill and Bloomington, Ind.

Genus CYTHERELLINA, *Jones & Holl.*

Cytherellina glandella, N. sp. **Plate 9, Figs. 28 and 29.**

Carapace minute, elongate ovate, a little wider at one (posterior ?) end and also more ventricose, while being compressed gradually toward the anterior extremity, presenting a somewhat cuneate aspect in profile. Upper and lower margins nearly equally cur-

* Misprint for *Cytherina.*

ved ; ends neatly rounded, length about twice the width, and the width nearly twice the thickness of the middle of the valves. Valves nearly equal, scarcely overlaping at their edges even on the basal margin ; the hinge line scarcely distinguishable. Surface of the valves smooth under an ordinary magnifier, but with a faint sulcus crossing them just behind the middle, and a slight tubercle between it and the broader end.

There is some doubt as to the true generic relations of this species. It seems to be more nearly related to *Cytherellina* than to any other which I can find, although the slight inequality of the valves required under the diagnosis of that genus does not appear on any of the very few specimens which I have observed. There is some little variation in the form of the different specimens in their proportionate length and breadth, and also in the regularity of curvature. Length of the largest specimen about eight one hundredths of an inch.

Locality.—Spergen Hill, Ind.

The following species have been observed among the collections from Spergen Hill, Ind., in addition to those described in the foregoing paper.

Foraminiferous (?) bodies, spinose. Genus and species undet.

Palæacis cuneatus, M. & W.

Zaphrentis elliptica, White.

Zaphrentis spinulosa, Hall (?). Small form.

Zaphrentis, sp. undet.

Dichocrinus simplex, Shumard.

Platycrinus sp. Base and separate plates, resembling *P. Saræ*, Hall.

Platycrinus sp. ?. Two or more species represented by plates only.

Synbathocrinus Swallovi, Hall.

Batocrinus irregularis, Casseday.

Batocrinus icosidactylus, Casseday.

Batocrinus ? biturbinatus, Hall.

Barycrinus magister, Hall. Stems and plates.

Cyathocrinus. Several species represented by detached plates.

Scaphiocrinus sp. ?. Arms simple, formula $\frac{2}{4}\overset{4}{\,}\frac{2}{4}$

Forbesiocrinus Wortheni, Hall.

Pentremites (Tricoelacrinus) obliquatus Rœmer—*P. Woodmani*, M. & W.

Pentremites (Tricoelacrinus) obliquatus, M. & W., not of Rœmer.

Coscinium escharense, Prout.

Stictopora, sp. undet.

Fenestella hemitrypa, Prout.

Fenestella. Two or more undetermined species.

Paleschara tuberculata—*Fustra tuberculata*, Prout.

Streptorhynchus crinistriatum, King (?).

Productus vittatus, Hall.

Productus semireticulatus, Martin.

Spirifera tenuicostata, Hall.

Spirifera Leidyi, N. & P.

Spiriferina spinosa, N. & P. sp.

Aviculopecten, Indianensis, M. & W. This species is exactly a minature of the specimens from Crawfordsville, Ind.

Macrodon obsoletus. The specimen which I have identified with this species is much water worn, but so far as preserved retains features exactly identical with specimens from the coal measures of Ohio as given by F. B. Meek.

Dentalium or Coleus, sp. undet. The specimens of this shell are so universally fragmentary and eroded that I have not considered it describable.

Chiton carbonarius, Stevens.

Phillipsia bufo, M. & W. On close comparison of this species with examples from Crawfordsville, Ind., I can find no difference of importance.

Fish teeth, several species and genera are known from the beds at Spergen Hill.

In some specimens from a bed of white and ferruginous chert from Tuscumbia, Ala., I find the following Spergen Hill species represented, as casts principally.

Pentremites conoideus, Hall.

Pentremites Koninckana, Hall.

Spirifera Leidyi, N. & P.

Spiriferina spinosa, N. & P.

Athyris hirsuta, Hall.

[*Oct. 20th,*

Athyris trinucleata, Hall.
Eumetria Verneuiliana, Hall.
Rhynchonella Grosvenori, Hall.
Rhynchonella mutata, Hall.
Terebratula turgida, Hall.
Terebratula formosa, Hall.
Platyceras acutirostris, Hall.
Euomphalus Spergenensis, Hall.
Spirorbis annulatus, Hall.

ARTICLE VI.—*The Atlantic Right Whales: A Contribution, embracing an Examination of*

I. *The exterior characters and osteology of a cisarctic Right Whale—male.*

II. *The exterior characters of a cisarctic Right Whale—female.*

III. *The osteology of a cisarctic Right Whale—sex not known.*

To which is added a concise résumé of historical mention relating to the present and allied species.

By JOSEPH BASSETT HOLDER.

BALÆNA CISARCTICA, *Cope.*

This, the Black Whale so called of the temperate Atlantic, was lately introduced to science as a re-discovery. After a lengthy period of well nigh total extinction, the species is now manifestly increasing in numbers.

As is now well known, after a long continued confusion of specific characters and consequent misunderstanding, this Right Whale is the one which our forefathers found abundant along the Atlantic coast, from Newfoundland to Florida. It is the one first hunted by the Cape Cod and Nantucket whalers; and is not the one now and latterly captured in the Arctic seas.

At the commencement of the American Revolution, the Black Whale had been so persistently pursued, that there remained in our waters seemingly no more to capture. Indeed, the species was near extinction. It was now that the New England and New Jersey whalers pushed northward and discovered the great Arctic Right Whale. As they found a prey affording them more oil and larger baleen, they were content; leaving others to settle the question of identity. The science of cetology was not then greatly advanced; it remained, therefore, for naturalists of a later period to fairly establish the characteristics and relative position of each species.

It is assumed from the known paucity of knowledge concerning the Right Whales, and the rarity of cetological works in this country, that some degree of usefulness to students remote from scientific libraries may result by adding an outline of published

[*May 1st*, 1883.]

matter relating to this subject. A summary of the history of the species is therefore placed at the close of this paper, and a short bibliography of works relating to this theme is also appended.

A complete history of the present species, so far as is known on this side the Atlantic, begins far back with the interesting paper by the Hon. Paul Dudley, F. R. S., published in the Philosophical Transactions of London.

Its first recognition by science, however, was through Prof. Cope. Its technical history, therefore, properly begins with his paper on the subject, which was published in the Proceedings of the Academy of Natural Sciences of Philadelphia for 1865.

Under the title "A Brief Account of the Osteological Characters of a Species of Whale-bone Whale, the Black Whale of our Coast," he continues: "They were formerly abundant along the mouth of the Delaware. A letter, dated 1683, from William Penn, states that eleven were taken that year. * * * A half-grown individual was taken and exhibited for some time, and its nearly complete skeleton occupies a prominent place in the Academy's Museum, in Philadelphia, and has afforded the best means of determining the affinities of the species. From examination it is evident that it is a species of the genus *Eubalæna*, Gray, therefore widely different from the *B. mysticetus*, and congeneric with the *B. australis* and *antipodarum* of the Southern seas. While differing in many points from the first, it is strongly separated from the last two, and has, no doubt, remained without proper notice up to the present time. * * * This species may readily occur on the European coast; and is no doubt allied to or the same as the species pursued by the Biscayan whalers."

Prof. Cope adds: "The skeleton will be more fully illustrated in a future publication." This, unfortunately, has never appeared; the present figures and descriptions of exterior characters are, therefore, the first that have been published relating to this Whale.

Up to the present year there were only three examples of this species known to science on this side the Atlantic; and two young specimens are in the Museums of Europe, viz.: at Copenhagen and Naples. The latter are named *B. biscayensis* by European authors, but are now regarded as identical with the *cisarctica*. All of these, five examples, are skeletons; no fair opportunity having occurred to examine and place on record the external characters until during the present year, 1882, when a nearly adult specimen was brought into New York harbor from off the New Jersey coast. Another specimen was examined by Dr. Manigault, of Charleston, S. C. Five of these species, therefore, are known in this country, though the New Jersey Whale was not preserved.

Of the three original skeletons in this country, one is in the Museum of Comparative Zoölogy, at Cambridge, Mass.; another is the Cope specimen, in the Philadelphia Academy, and the third is in the American Museum of Natural History, in Central Park, figured here in plate xii. A fourth is now added in the excellent and quite perfect specimen prepared by Dr. Manigault for his Museum at Charleston College.

THE PHILADELPHIA WHALE.

Dr. Cope's description and measurements are as follows:

Total length, ...	$31\frac{1}{2}$ feet.	
" " including vertebral cartilages,	37 "	
Length of head, axially, ...	8 "	5 inches.
Number of vertebræ, ...	56	
" " ribs, pairs, ...	14	
Height of scapula, ...	23 inches.	
Breadth of "	29 "	
Breadth of nasal bones, ...	3 "	
Length of " "	$9\frac{1}{2}$ "	
The first vertebra from the cranium, showing the vertical foramen through the diapophysis, is the	38th.	
The last vertebra, counting from the cranium, that has the neural spine strongly developed, is the	44th.	
The anterior zygopophysis, counting from the cranium, is first definitely separated on the .	17th.	

The cervicals are all united; the posterior three by the lower part of their centra only; above they form a solid crest, the atlas and the last attached by the superior part of their neural arches only.

The fourth, fifth and sixth cervical diapophyses are distinctly united on one side, while the remainder are separate; on the other side the seventh is united with the three posterior, and the three anterior are united. The first, second and third only have inferior transverse processes.

Of the ribs, the anterior are single headed.

Of the dorsal vertebræ, the first four have slender elongate diapophyses.

The above is essentially Prof. Cope's statement, though we have taken the liberty to re-arrange the items for more convenient comparison with those of the other specimens in question.

Prof. Cope presents also considerable matter relating to the periotic region, which has less significance for our immediate purpose, our examples, unfortunately, having none of the members by which to estimate comparisons. It is matter of regret also that our specimens have no chevron bones, nor hyoid and pelvic elements.

During the preparation of this paper, a most fortunate accession to its usefulness occurred through the discovery to us by Dr. Manigault of his Charleston Whale. According to authors, the occurrence of a male Whale near shore is not frequent; the females being more subject to capture from the reason that they seek more inland waters during their breeding season. It is, therefore, fortunate that our two fresh specimens were of opposite sexes, the Jersey specimen being female. We have received from Dr. Manigault a communication, in which he records in very interesting terms the method of capture, as well as most valuable descriptions and figures relating to its osteology. The nature of this paper necessarily precludes the introduction of what otherwise would prove highly interesting. Some portions, however, that relate to characteristic habits, &c., as well as the valuable technical portion and excellent figure of the *cranium*, are regarded as important contributions, which are here gratefully acknowledged.

THE CHARLESTON WHALE.

Communicated by Dr. Manigault.

"*Dear Sir :*

In compliance with your request I send you an account of a Right Whale, captured in the harbor of Charleston, S. C., in January, 1880, the skeleton of which I have since prepared and mounted in the Museum of our City College.

"A few days after the 1st of January it was observed that there was a large Whale in the harbor; several timid and ineffectual attempts were made to procure his capture, until a regular hunt was organized on the 7th of the same month. One of the crews engaged succeeded in fastening a harpoon in his body while the Whale was near Fort Sumpter. Pursuit was continued by the same boat until the Whale had worked his way to landward, in the neighborhood of Fort Johnson. He remained in shoal water during the morning, and in the afternoon about half-past one a much larger attacking force started in pursuit, consisting of four steam tugs, between fifty and sixty row boats, and a few sailing craft. The line attached to the harpoon which was thrown into him in the morning was taken on board the tug, and it was attempted to coax the animal towards the city. The steamer proved too unhandy for the work, and finally the line snapped. Repeated attempts were now made to throw harpoons at him from the tugs, and also to throw running nooses over the flukes of his tail. His struggles and manœuvres at this time were surprising. Occasionally he seemed to stand on his head, apparently for several minutes, with several feet of his tail projecting above water. After several hours of chasing, including repeated blows from the bows of the tugs, he expired.

"The animal displayed great strength in his plunges and other movements. At one time he got beneath the bows of one of the tugs, lifting it almost clear of the water; and a stroke of his tail wrenched off one of the cabin doors that stood open.

"This Whale was exhibited during the two following days, and was then turned over to me. I contented myself with removing the baleen from the mouth. The blubber was in so thin layers that the process of boiling it down was not a paying one to the original owners.

"I removed the eyes, and presented them to a medical friend, to whom they were of service in his lectures on the eye. They were two and three-quarter inches in diameter, with a very thick sclerotic coat; and the pupils were oval in shape.

"I was able to ascertain with certainty that the creature was a male.

"I closely inspected all the work so that nothing should be left behind. I was particularly careful when the bones were being cut out of the flippers to see that every one was taken out, and kept them entirely separate during maceration. If the results are the same in other Whales of the same age, it must be taken as conclusive that the carpal bones are developed only when the animal is approaching adult years, for there were none in this specimen and but few phalanges.

"The only bones that are wanting, and which were probably lost, are two small undeveloped ones of the rudimentary pelvis.

"I consulted Prof. Cope about the identity of this Whale, and we agreed that it is the Black Whale, similar to the one described by Prof. Cope under the name *Eubalæna cisarctica.*

"The Charleston Whale differs somewhat in some of the minor details of its osteology, but these are trifling, and cannot be considered as vitiating its identity.

"This Black Whale is now sufficiently abundant off the coast of South Carolina and Georgia for its fishery to be carried on to a limited extent. One or two schooners have been fitted out in the harbors of Port Royal, S. C., and Brunswick, Georgia, for this purpose, and several captures have been made. A few weeks after the capture of the Charleston specimen, a Whale sixty feet in length was cast ashore on the beach at Sullivan's Island, which had already been stripped of its blubber and baleen at sea.

"One of the sailors who plied the harpoon with the most skill in the above-mentioned chase, who had some experience in the whale fishery, told me that a few nights before the whale was seen in this harbor, he had remarked while on deck at night at anchor off the harbor, the peculiar odor of whale feed, with which he had become familiar in his voyages.

"I enclose with this a drawing which I have had carefully made of the head of our Whale.

"With great respect,

G. E. MANIGAULT, M. D.,
Curator of Museum,
CHARLESTON COLLEGE, S. C."

[*May 1st,*

DESCRIPTION AND MEASUREMENTS OF THE CHARLESTON WHALE:

By Dr. Manigault.

Total length in the flesh, . . .	40	feet	4	inches.
" " in the skeleton, . .	35	"	7	"
Length of cranium, ...	9	"	8	"
" " mandible, axially, . .	8	"	9	"
" from muzzle to axilla, .	10	"	2	"
" of fore limb, ...	6	"	7	"
Girth in front of fore limb, . .	22	"	4	"
Space between fore limbs on abdomen,	6	"	5	"
Baleen, longest, ...	4	"	2	"
" number of plates on each side, .			180	
Vertebræ, number, ...			57	
Ribs, pairs, ...			14	
Scapula, height, ...			21	inches.
" breadth, ...			35½	"
Nasal bones, long, ...			10½	"
" " wide, ...			4	"
The first vertebra from the cranium showing the vertical foramen through the diapophysis, is the				38th.
The last vertebra, counting from the cranium, that has a neural spine, is the				45th.
The anterior zygapophysis, counting from the cranium, is first definitely separated on the .				16th.

The seven cervical vertebræ are united; the posterior four in the lower part of their centra only.

Above, the only ones that are united, and thus form a solid crest, are the first six, the seventh or last being entirely separated from the others in every part except the lower centrum.

On the right side, the diapophyses of the third, fourth, fifth and sixth are all united, the first and seventh being separate.

On the left side the fourth, fifth and sixth are united, the others being separate; the second, third and fourth alone have inferior transverse processes.

The first rib has but one articulating surface, which joins to the transverse process of the first thoracic vertebra. The next eight ribs are joined to the vertebræ by two articulating surfaces, one junction being to the transverse processes, and the other to the bodies of the vertebræ. The remaining *five*, floating ribs, have one attachment, which is to the bodies of the vertebræ.

THE NEW JERSEY WHALE.

This Whale was captured off the New Jersey coast by a crew of experienced Egg Harbor whalers, by the usual method of harpooning. It was exhibited during several weeks of the spring of 1882, the body being preserved with tolerable success by injections of poisonous liquids into its muscular tissue. Meantime opportunity was offered us, under some restrictions, to examine the exterior. At this time the extraordinary value attached to the carcass precluded all chance of securing any prospective interest in the skeleton.

A general view of the exterior shows most graceful proportions of a comparatively slender and mobile form, terminating caudally in a festooned expansion of the most pleasing contour; in this respect contrasting strongly with the massive and homely outlines of some others of the larger forms.

The skin was a dense "ivory black," having but few molluscan parasites; those being confined to the lower lip. Most notable features are the graceful and characteristic outlines of the produced muzzle, the great depth through the frontal orbital region, and the rearward aspect of the spiracles.

A closer examination shows the head to be about one-fourth the entire length; the depth, or perpendicular diameter of the head to be about the same dimensions as that of its length from the orbit forward.

The spiracles are, in form and relation with each other, much like those of *mysticetus*, but are situated on an inclined plane, presumably formed by elevation of the frontal where its suture closes with the nasals.

If this is correct, the highest point of the cranium must be at that juncture. The short exposure of the frontal, instead of being directed horizontally or forwards, faces quite rearward, continuously with the occiput. This will account for the striking relative position of the spiracles with features of the cranium in profile.

The recurved *rictus*, so well indicated by the old authors—"*Rictu amplo forma litteræ S curvato*"—was strongly marked in our whale; the border of the maxillary forming an elegant curve under and around the orbit. One would look to find the zygomatic portion inclined forwards considerably to produce this sharp deviation from the bow outline seen on its perpendicular aspect. Whatever it may have been in reality (for there was no opportunity to examine in this case), the Charleston cranium does not exhibit such a form, but the outer border of the maxillary approaches so nearly an arc, that a circle described by sweeping the dividers from the lower and deepest borders of the baleen comes surprisingly near being in perfect relation to it.

The high, upright, and intensely solid under lips have an edge of about eight inches breadth; the superior and anterior aspects having a crenulated appearance, produced by irregular transverse sulcations of about three inches depth; the inner surfaces being lighter in color or nearly white.

The baleen at its longest measured five feet nine inches, and seven inches at the greatest width. Its appearance is much like that of *mysticetus*, apparently not coarse, as is often said of the "second species" of older authors.

Along the front of the muzzle, and extending backwards about three feet, where it is lost in the general contour, is a low sharp *carina*, which outlines the base of the nasal protuberance. This is shown in Plate X, and in Plate XI, fig. 2. The latter figure is from a photograph (kindly loaned by Mr. Daniel Beard), and verified by drawings and measurements taken from the fresh animal. The peculiar and graceful roof-like muzzle, the baleen, and the great mass of tongue, are well shown here.

The extraordinary depth of head in this Whale, compared with figures of *mysticetus*, is surprising, particularly when it is remembered that during a long period the two were regarded as one and the same species.

The mucous membrane of the mouth was of a delicate pale pink hue; that of the tongue being considerably lighter in color.

The region of the symphysis of the mandibles is so strongly developed, as seen in fig. 2, Plate XI, as to give the effect of a development like that on the muzzle; but unlike that, which is wholly due to adipose deposit, they are produced *termini* of the mandibles.

MEASUREMENTS OF THE NEW JERSEY WHALE:

Total length in flesh, ...	48 feet.	
Length from muzzle to orbit, . .	12 "	
From highest cranial eminence to orbit, axially, ...	9 "	4 inches.
Depth through the same to abdomen, about	12 "	
Length of fore limb, ...	7 "	
Width of fore limb, ...	3 "	10 "
External ear, above the horizon of the eye, ...		7 "
External ear, distant from the vertical axis of the eye, ...		16 "
Distance between the anterior face of the axilla and the eye, . . .		29 "
Circumference of the caudal terminus, or "small" of body, ...	6 "	8 "
From the "small" to caudal bifurcation, ...	4 "	
Extreme expanse of flukes, . . .	17 "	
Length of each fluke, axially, .	10 "	
Breadth " " " . . .	3 "	11 "
Spiracles, length, axially, . .		12 "
" divergence posteriorly, .		16 "
Baleen, longest, ...	5 "	9 "
" width, ...		7 "
Nasal prominence, width, . .		16 "
" " height, . .		22 "

THE NEW YORK WHALE.

This specimen is represented by a skeleton of a whale which came ashore several years since on Long Island.

The Hon. Peter Cooper, with an eye, as is his habit, to benefitting some educational institution, purchased the bones. They were found too cumbersome for use at Cooper Institute, and were stored until the American Museum was organized, when Mr. Cooper presented them to the latter institution. The skeleton was skillfully mounted in the old Arsenal, and formed nearly the first object around which the present fine collections were gathered.

Several of the caudal vertebræ are missing, as well as the chevron bones, the periotic and the hyoids. The zygomatic portion of the maxillary is also wanting, and what there may possibly exist in this species of the pelvic elements. Most of these portions of the skeleton are lost in the preparation through ignorance of their presence or value. As this paper is likely to fall into the hands of individuals familiar with its subject on our shores, some information on the importance of these small elements, and the great desirability of preserving them when a carcass is being cut up, may be in order here.

The rudimentary hip bones and the attached bits of bone that represent the thighs in the great Northern whale are now well known to ceteologists. Whatever then may be in other whales of this character, as well as the ear bones, bones at the root of the tongue, small bones on the skull that are so easily detached during decomposition or maceration, should be carefully preserved. When the hip or pelvic bones are present they float in the flesh just under the vertebræ, about over the vent.

A portion of the baleen of this whale is attached to it, though, from rough usage, it has become frayed at the edges, and shows but little of the compact and smooth aspect seen in the fresh New Jersey specimen, and also in the Charleston one.

MEASUREMENTS OF THE NEW YORK WHALE:

Total length, including intervertebrals,	35 feet.		
Length of mandible, ...	10 "	3 inches.	
Distance from frontal eminence to orbit, axially, ...	3 "	2	"
Distance from frontal eminence, axially, to angle of mandible, . . .	5 "	2	"
Nasal, long, ...		9	"
" broad, ...		5	"
Baleen, extreme length, ...	4 "	6	"
" width at proximal end, . .		6	"
Scapula, height, ...		30	"
" breadth, ...		37½	"
Ribs, number of pairs, ...		14	
Vertebræ, probably		57	

The seven cervicals are all united in their centra, forming practically one piece; the intervertebral substances and spaces being nearly obsolete. In the seventh the intervertebral space is somewhat more marked, though only as a more or less shallow sinus.

Viewed on the right side, the atlas and axis coalesce at their neural spines.

The axis, third and fourth cervicals, have their neural arches massed in one.

The neural arch of the fifth cervical is united to that of the fourth by the neural spine only.

The neural arches of the sixth and seventh cervicals are united by their neural spines only.

The diapophyses of the atlas, axis and third cervical coalesce at their distal ends.

The diapophyses of the fourth, fifth and sixth cervicals coalesce at their distal ends.

The diapophysis of the seventh is free.

On the left side, the neural arches of the atlas and axis are united at their neural spines.

The neural arches of the axis, third and fourth cervicals are massed in one.

The neural arches of the fifth and sixth cervicals are united by their neural spines only.

The neural arch of the seventh cervical is free.

The diapophyses of the atlas, axis and third cervical coalesce at their distal ends.

The diapophyses of the fourth, fifth and sixth coalesce at their distal ends.

The diapophysis of the seventh cervical is free.

The members of the fore limb below the radius and ulna are missing, with the exception of a few phalanges.

The first rib has a perfectly simple and smooth proximal terminus; its body being a thin curved blade, seven inches in width at the distal end.

On making a comparison of the three skeletons, we find the same number of vertebræ in each, counting from the cranium, and allowing the loss of several terminal caudals from the New York example. The first vertebra from the cranium showing the vertical foramen enclosed by the diapophysis is the thirty-eighth in each.

There is correspondence between the Charleston specimen and the New York one in that the last neural spine stands on the forty-fifth vertebra. In the Philadelphia Whale it is seen on the forty-fourth, or as Prof. Cope says: The neural spine is strong on the forty-fourth, therefore, possibly the forty-fifth may exhibit the same amount of development in his specimen as is seen in the two others.

So with the anterior zygopophysis, which is developed on the tenth vertebra, and on the ninth in the two others in question.

An agreement exists in the number of ribs in each—there are fourteen pairs.

Considerable discrepancy is seen in the sums of measurements of the scapulæ.

The three skeletons are so nearly alike in length as to be regarded as practically the same. Adding a caudal to the Charleston Whale, which is due, and several to the New York one, also due, we have for lengths: thirty-six feet, thirty-six to thirty-seven feet respectively, and thirty-seven feet given for the Philadelphia Whale. Thus for three examples of the same length, we have the scapulæ exhibiting the following measurements:

	In. high.		In. broad.
Scapula of Charleston Whale, . .	21	×	31½
" " Philadelphia Whale, . .	23	×	29
" " New York Whale, . .	30	×	37½

The scapulæ of the Charleston and Philadelphia Whales agree very nearly in proportions; but the sums of measurements in that of the New York Whale are strikingly greater. The acromion is not mentioned in the descriptions of the two former. In the New York example it is well developed: nine inches in length, and of uniform width of two and a half inches.

The crania in the Charleston, Philadelphia and New York specimens agree nearly in proportions.

Though we are not able to produce exact measurements of the bones of the cranium of the New Jersey Whale, yet a near approximation may be assumed.

In the Charleston Whale the length of mandible is eight feet nine inches, and the depth of cranium from frontal to orbit, is axially, three feet and ten inches, or the entire depth through, perpendicularly, five feet.

In the New York Whale the length of mandible is ten feet three inches; the depth from frontal to orbit, axially, is three feet two inches; and the entire perpendicular diameter of the cranium is five feet.

The Philadelphia Whale has an axial length of mandible of eight feet five inches; the perpendicular diameter of cranium is not given.

Compared with the above, the New Jersey specimen in the flesh exhibits the following sums of measurements:

Length of mandible, axially, twelve feet; depth of cranium, from frontal to orbit, nine feet four inches; perpendicular diameter of body through the cranium, twelve feet.

The respective sums are then:

Charleston Whale, . .	5	feet by	8	feet	9	inches.
New York Whale, .	5	"	10	"	3	"
Philadelphia Whale, . .	—	"	8	"	5	"
New Jersey Whale, .	12	"	12	"		

Something may be allowed for the latter being in the flesh, although the condition of the carcass was such that the rami of the mandibles rested very closely to the ground. The measurements are therefore nearly accurate.

This is, certainly, a remarkable difference in proportions, especially between the New York and New Jersey specimens. In the absence of other examples of different sexes for comparison it is not possible to determine the significance of this variation.

We have submitted this point, among some others, to the notice of Prof. Flower, of the Royal College of Surgeons of London, who is inclined to regard the difference as due to either age or sex. We have seen that the ages are too uniform for any peculiar features to be due to such agency. The Whale under consideration was a female; if, therefore, this example is specifically one with the others herein treated, the short head may be a sexual character.

Dr. Manigault saw nothing on his male specimen that corresponds at all to the beautiful fleshy development of the muzzle in our female Whale.

It is a matter of regret that no opportunity was offered to dissect the region of the spiracles, as the rearward aspect of those organs is quite striking as compared with other examples. In the cranium of the New York Whale the nasals are situated seemingly much farther forward than those of the fresh New Jersey specimen. In the latter a line drawn along the straight face of the orbital portion of the frontal will intersect the spiracles. A line along the same region in the New York cranium leaves the nasals a considerable distance anteriorly, and forward of the cranial eminence; while in the other case the spiracles face backwards on inclined ridges. Seen in Plate XI, fig. 3.

The skeleton of the New York Whale was lithographed from three separate sections of photographs, hence it should be regarded as three parts placed in juxtaposition; the apparent errors will then be understood. The cranium was taken at so low elevation that the nasal profile is not well shown; we have, therefore, presented a view separately, fig. 7, Plate XI, to show the relative situation of parts. A view is also given of the nasals as seen from above, fig. 8, Plate XI.

Figures representing the cervical vertebræ, and one each of the lumbar and caudal, are seen on Plate XI.

In the figure of the Charleston cranium, Plate XIII, the upward curve of the mandible is so great that we regarded it desirable to verify the artist's work. Dr. Manigault, therefore, kindly replies: "It is possible that the artist was a little inaccurate in drawing the outline of the lower jaw. Of course I recognize the fact that a photograph of the head would be more accurate than a drawing, but before sending you the latter I examined it with a skull in view, and was tolerably satisfied with it. I have since examined the profile of the skull, with the drawing in hand, and consider the whole quite correct. There is an undoubted bend upwards in the lower jaw."

A communication in *Canadian Naturalist* for 1871, Vol. VI, No. 2, entitled "The Whale of the St. Lawrence," by Dr. J. W. Anderson, exhibits some facts pertinent to our subject.

It relates that two Right Whales were found far up the St. Lawrence River, and gives some measurements that would seem to be of importance as coming from what we must infer is a most reliable authority. The writer says: "Early in August of this year, (1871) two whales were seen sporting near the shores of the Gulf. A Mr. Chabot, who claimed to have invented a gun harpoon, discharged his piece at the whale. As the rope returned without the harpoon it was thought that the whale had been struck. Some days afterwards a whale was discovered on the beach at St. Joachim. I was not prepared to see so huge an animal. It was supposed that the two had been a female and young. It turned out to be an aged male, apparently the species *Balæna mysticetus.* I measured it as accurately as I could, and satisfied myself that it was sixty-five feet in length. The back was black, the belly furrowed, presenting the appearance of a clinker built boat, and each furrow alternately black and dingy white. The baleens were quite perfect, and I secured some plates. I concluded, after a careful examination, it answered fully the description given by Dr. Dekay for the *mysticetus.* According to my measurements, corroborated by Mr. Gregory, as the whale lay upon the beach, he was sixty-five feet long. The fluke of his tail twelve feet; his jaw, fifteen feet. When the skeleton was brought to the city I had an opportunity of verifying to my own satisfaction the correctness of the first measure. The jaw bone measures exactly *fourteen feet six inches.* A whale of this size ordinarily would yield sixty barrels of oil; this gave only *six.* This may well be accounted for by his being aged, diseased and worn out. No wound was found on his body, hence the harpooner could not claim the prize. It is likely the great creature had long been suffering for proper food, and now encompassed in a close bay or river he quickly succumbed."

This is interesting in several points. It is pretty certain if the creature was really a *Balæna* and not a *Balænopter*, it was an example of unusual size. But what more concerns us are the proportions represented in the measurements of the head and body. The length of the baleen, unfortunately, is not given; a most surprising circumstance, as the flakes must have been (if it was *mysticetus*) at least fifteen feet long.

The furrows on the belly naturally suggest the *Balænopters*, but it is inferred that there was no dorsal fin. The great age and extreme emaciation may have produced folds and wrinkles on the abdomen.

The whole length, we have seen, is given as sixty-five feet, and that of the head as fifteen feet. According to our present knowledge the *B. mysticetus* has the head near one-third the total length of the body. It is also known that the male of this latter species has a longer head than the female. Scoresby was convinced that there were other species of Arctic Whales, and judged evidently from this difference between the sexes constantly appearing before him in his numerous seasons of capture. The proportions of this whale are more those of *B. cisarctica*. The great length again suggests the *mysticetus*, as even for that species it is five feet longer than is usually seen.

This example is valuable for record—

1st, As a specimen of unusual size.

2d. As one of great age.

3d. As one out of its usual habitat in so far as to be quite within fresh water.

The author relates the facts concerning another whale which was stranded in the St. Lawrence in 1823. It is extracted from the *Canadian Magazine*, Vol. I, and is as follows:

"About the middle of September, 1823, a large whale found its way up the St. Lawrence till nearly opposite the village of Montreal where it continued to play itself for several days—not being able to navigate down the river. * * * * After a week's exertion it was harpooned. It was found to measure forty-two feet eight inches in length, and seven feet deep.

Prof. Flower, in his admirable edition of Eschricht and Reinhardt's work, in considering the probabilities of the Arctic Whale having once penetrated so far south as the mouth of the St. Lawrence River and entered the fresh water, refers to an account of a whale being found in the St. Lawrence River in the year 1823, and expresses the opinion that it was "one of the White Whales, *Beluga*, that are so common at the mouth of that river." This account in the *Canadian Naturalist*, (probably the same referred to) would seem to set the matter aright; and the second example, much more singular in its features, shows that the largest of the Right Whales have really found their way as far up a fresh water stream as Quebec and Montreal.

The larger of the two whales was definitely ascertained to be a male. The circumstance of a male *mysticetus* being sixty-five feet in length, gives color to the possible existence of females even larger, if we are to conclude that the sexes differ essentially in length. Here, however, it may be fair to admit the qualifying influence of extreme age.

There is no mention of a nasal protuberance. The Charleston Whale, a male *cisarctica*, had none. So far, therefore, there is nothing to discountenance the assumption that this St. Lawrence Whale was the latter species, excepting, perhaps, the great size. The most suggestive fact is in the proportionate size of the head to the body, which is more in accord with the *cisarctica*. The assumed fact that the male *mysticetus* has a larger head than the female, lends strength to this proposition. Eschricht and Reinhardt say: "The male, though somewhat smaller than the female, will nevertheless be found to have a much larger head, even absolutely speaking." They also add: "The length of a Right Whale cannot, by itself, excepting in rare cases, be of use in determining to what species it belongs."

Prof. Flower, in his Appendix to Eschricht and Reinhardt's work, already quoted, says: "About fifty feet is the average length of the Greenland whale of either sex." Concerning the differences of proportion, he adds: "Such difference as exists is certainly in favor of the males, * * * and there can be no question that age leads to important modifications, especially to a great increase of development of this part of the body. It is possible that the arch of the upper jaw, and consequently the length of the baleen, is generally greater in the male than in the female." In the examples we have seen and compared, the New Jersey specimen (female) and the Charleston specimen (male), the baleen was about the same length in each.

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THE RIGHT WHALE OF EUROPE.

Balæna biscayensis. Escht.

The identity of this and the *Balæna cisarctica*, Cope, is now pretty well established. Prof. Flower, while acknowledging the receipt of a proof impression of our figure of *B. cisarctica*, adds of Cope's type: "As far as I can make out it is the same as *B. biscayensis*," and continues, referring to our figure, "I cannot help remembering, in passing, that it most closely corresponds (allowing for inevitable difference of drawings made under difficult circumstances) with figures of the Southern Right Whale, given by Dieffenbach, and of the Japanese by Siebold, and also, in a native drawing in my possession."

Prof. Cope has expressed himself satisfied that the two are identical.

Prof. Allen, of Cambridge, Agassiz Museum, alluding to our figure of the New Jersey Whale, says: "Your drawing of the recent specimen agrees well with figures of *B. biscayensis* of southern Europe, which I believe to be identical with Cope's *B. cisarctica*."

Eschricht and Reinhardt have given their convictions of the same, regarding the "Sarde" of the Basques, the "Nordcaper" of the old Dutch and North German whalers, as most probably the Right Whale of the Anglo-Americans, from the coast of Nantucket and New England."

The figure in VanBenedin and Gervais, *Osteographie des Cétacés*,[60] being of some young individual, cannot of course be compared so satisfactorily. Yet it exhibits something of the strong characters of the *rictus* and other portions of the head. The upper jaw and lip are singularly small compared with the lower, which may be due to the immature age, although its length, 26 feet, would seem to indicate an individual large enough to have reached somewhat more of adult form.

The figure of Capellini's specimen, in Southwell's work,[55] has more of the appearance of *mysticetus* than of *biscayensis*. It is quite like Scammon's[63] figure of the Northwest Right Whale (*B. Sieboldii*), having none of the sharply recurving *rictus*, but the same long sigmoid outline seen in the latter. Its head, also, is much too bulky to represent the Nordcaper, being one-third the total length. The length and other measurements of this whale are not given. Of the skeleton of this, the Taranto specimen, now in the Museum of Comparative Anatomy of the University of Naples, Prof. Gasco says: "Both the Taranto Whale and that of Philadelphia (*B. cisarctica*, Cope,) belong to the species *B. biscayensis*, of Eschricht.

We have here an epitome of the history of the species and a seemingly satisfactory understanding of the characters and mutual relations of the two forms, viz.: the Atlantic Right Whale of Europe and the Atlantic Right Whale of America; and a nearly uniform decision establishes their identity. Fischer, however, dissents, and regards them as distinct species. (See VanBenedin and Gervais, Osteographie, &c.[50]).

The figure in *Fauna Japonica*,[27] *La Baleine des mers Australis*, (*Balæna antarctica*) being that of an adult, is of interest in comparison with our New Jersey specimen, as it is much more like the latter than any other figure extant. It is probable that the caudal region, flukes and pectorals are represented as too stout. Otherwise the figure is a close copy of the latter whale. The nasal hood, and the short, sharply recurved *rictus* are well expressed. Even the exceedingly crude wooden model of Chamisso will impress any one that has seen the Atlantic Whale as having several of the characteristic features of the second species, which are wholly absent in more pretentious works.

Scammon's figure of *Balæna Sieboldii*[63] in the absence of any description, is scarcely comparable. It does not bear the peculiar curve of the mouth, but, far from it, exhibits an elongate sigmoid outline. The species is said to bear a "bonnet" on its snout, which is represented in the plate by an irregular bunch, seemingly covered by parasitic molluscs.

As these several examples of Right Whale are regarded as, if not the same species, certainly of one group, having peculiar features which distinguish them from the species *mysticetus*, it is pertinent to determine what those characters are. The graceful outlines of the produced snout in the New Jersey Whale are certainly not represented by the figure of *B. Sieboldii*. The mouth of the latter varies but little from that of *mysticetus*, and the head bears the same proportion to the body as obtains in the latter.

Capt. Scammon's description of his *B. Sieboldii* corresponds with his figure. He says: "Its average adult length may be calculated at sixty feet—it rarely attains seventy—and the two sexes vary but little in size. Its head is very nearly one-third the length of the whole animal. So far one would be led to recognize a variety of *mysticetus* rather than one of the "second sorte" for only one of the external characters of the latter are shown, and that, the "bonnet," as shown in this figure, is not by any means what it is on the *cisarctica*, and unfortunately no description is given of it. Judging of the figures extant there seems to be a most remarkable confusion of external characters. Scammon's *Balæna Sieboldii* is credited to Gray. The latter author—*Catalogue of the British Museum, Seals and Whales*—records it as synonymous with *B. australis*, Temminck, *Fauna Japonica*," plates 28 and 29 (from Japanese model). The latter, we have seen, is a good figure of *cisarctica*, and the former, entirely lacking the external characters of *B. australis*, does exhibit very nearly the characteristics of *B. mysticetus.*

We do not propose to attempt to harmonize the conflicting elements, but as we have presented a faithful delineation of the Right Whale of our Atlantic side, with certain figures and facts relating to the osteology of the species, we hope to lessen the confusion by directing the attention of cetologists to such as are absolutely correct, and of certain value.

It is to be hoped that the long lost Black Whale will find a resting place in systematic cetology, for it exhibits characters equally at variance with recorded generic values, whether it be *Balæna* or *Eubalæna.* Gray's *Eubalæna* calls for "first pair of ribs broad at vertebral end, and a coracoid process on a scapula as long as broad." This certainly does not accord with *cisarctica*, which has the first rib very narrow at the vertebral end, rapidly widening to the distal terminus. The scapula of the latter is strongly broader than high, and has no trace of a coracoid. Prof. Flower's record of *Eubalæna* calls for 57 to 58 vertebræ in lieu of the 52 of *cisarctica*, and one more pair of ribs; the type being *E. australis*, Desm.

The scapula standard set up in Gray's family *Balænidæ* seems faulty in that three of our specimens of Atlantic Right Whales exhibit the scapulæ as much wider than high, instead of as in Gray, "scapula higher than wide."

Some variations in the relative proportions of the cranial elements are noticeable. It occurs that possibly the greater length of head in the male may be due in some measure to the very considerable elongation seen in the occipital region of the latter as compared with the same in the other examples. In the female *B. australis*, as we see it in a photograph of the specimen in the *Jardin de Plantes*, and also as figured by VanBenedin and Gervais, the angle formed by the posterior face of the occipital bone and the nasal plane is about 120°. The same on the "New York Whale" is 145°. As the sex of the latter is not known it is impossible to form any definite conclusions. We know however that the several female specimens have uniformly short heads. The occiput of *B. antipodarum* and of the *B. australis*, as above, is nearly perpendicular to the plane of the nasal region, giving a shortened, truncated aspect to the brain case. The same is no doubt the case with our New Jersey Whale, judging from its short head.

In the Charleston Whale, a *male*, the occipital region exhibits the same elongated outline that is seen in the New York Whale. We have, therefore, what may be regarded as a basis for comparison :

B. antipodarum and B. australis, females, having the short head, with a truncated aspect of cranium ; the occiput forming, with the nasal plane, an angle of 120°. *B. cisarctica*, the New Jersey specimen, female, has the short head, and probably had the same angle as above.

The *B. cisarctica*, male, Charleston specimen, and the New York Whale, sex unknown, have the elongate head, with occipito-nasal angle 145°. The striking difference seen in the relative situation of the spiracles in the several examples, will, probably, be found to be due to the more or less production of the supraoccipital.

HISTORICAL.

The occurrence of a Right Whale on our coast, though something of great frequency—as is now known—in the earlier days of the Republic, has, after a century of nearly an entire absence of the species, recently come to notice through its occasional capture.

The circumstance that this whale became, through well known causes, nearly extinct before the time of Cuvier, when less attention was directed to essential points of structure, readily accounts for the meagre knowledge we find recorded.

When the great French anatomist came to review the field of cetological literature, his entire confidence in Scoresby's[1] views blinded him to all others.

Scoresby, through his great experience in the whaling service, made it possible to record most valuable information concerning the great Arctic Whale, but his inability to portray the subject pictorially was a misfortune.

Had he omitted his drawings, which were evidently ill-considered and taken at second hand, and had he confined his opinions to the experiences of the Arctic Circle, where his observations were exclusively limited, a very different record would have been established as the basis of the history of Right Whales.

It is known that from an early date, a Right Whale, differing from the Arctic form, was familiar to the various seafaring peoples of the European seaboard as inhabiting the more temperate waters, and that many ancient authors record accounts of such.

In 1808, Scoresby[1] published in the Wernerian Society's Journal the results of his observations; and later, in his more pretentious work on the Arctic regions.

His antecedents and present standing naturally claimed for him an especial degree of confidence in his statements. Cuvier was now preparing his great work, *Researches sur les Ossemens Fossiles*,[2] and had in this and in his first edition of *Regne Animal*, 1817, introduced the "Second Species" under the title "Nord-caper" (*Balæna glacialis*), Klein. He now, however, became fully convinced that Scoresby should be credited with the only exact knowledge; and on the strength of an assurance from the latter that the "Second Species" was no more than a "Fin-back," or at most an emaciated *mysticetus*, he abandoned it, with certain criticisms on the validity of the alleged species, in "*Sur la Determination des diverses especes de Baleines vivantes.*" For example, the author says: "The only document furnished of such authority that one may believe, consists of figures made by Backstrom, and sent by Sir Joseph Banks to Count La Cepede,[3] which he has engraved in his '*Hist. Naturelle des Cétacées*.' The figures would appear to be different from that of the Right Whale as long as one takes only [in comparison] the last of Marten's;[4] but to-day we have of this whale a recent and exact representation in the work of Captain Scoresby.[1] It is sufficient to compare it with that of Backstrom to be convinced that the two are one and the same species."

Now, curiously enough, the eminent whaling captain was, unwittingly, a stumbling block here. Secure, in his own opinion, he went astray to criticise La Cepede's figures, yet had failed most essentially in his own. Had Scoresby omitted his illustrations, the descriptions and measurements would have stood as undoubted, reliable matter for comparison. But he furnished to science an incorrect figure, at second hand, thereby making as gross an error as he charged on La Cepede.

Nearly every book published to this day, having an illustration of *B. mysticetus*, shows a manifest copy of Scoresby's figure. This is the more to be deplored as the figure is incorrect in several essential features, the relative size of head being a notable one. Several prominent works on Natural History of the latest issue repeat the same error.

No doubt Scoresby's figure resembles *B. mysticetus*, and so does La Cepede's figure, the *Nordcaper;* but they are about equally possessed of certain misproportions; the former of too short a head, and the latter having too short a body. So far, then, the authors are at quits. But little more exaggerated is *B. franche* of La Cepede. Though it may not have its "counterpart in nature," as Scoresby sneeringly said, if we remove a portion of its diameter the figure will give a tolerable representation of *mysticetus*, which it is intended to be. The latter figure is either the original or copy of others which are seen in nearly all the old authors on the subject. Had Scoresby copied some one of the old copper plate etchings, and toned it in accordance with his own observations and measurements, he would have given to science a more reliable and truthful standard of comparison, and left Cuvier the opportunity to establish two well marked species of Right Whale, aside from *Baleine du Cap.*

We may now see how well justified was Cuvier in his conclusions from premises supplied by Scoresby, which resulted in the rejection of a "Second Species." The figures of Marten's,[4] which he refers to, being like those of Zordrager,[5] quite good representations of *B. mysticetus*, he naturally notices that "they would appear to be different" from those of La Cepede representing the Nordcaper. So they were, despite the want of a longer body in the latter; they were for all that sufficiently characteristic of each species for general purposes. But Cuvier, unfortunately, is diverted from the correct course by accepting the figure of Scoresby, as we have seen, instead of relying on the description, and of which he says in continuation: "But to-day we have of this whale a recent and exact representation in the work of Capt. Scoresby," &c., &c.

It is a singular commentary on the utter confusion of the subject at that time, and lack of good modern descriptions and drawings, when we find, in spite of Cuvier's adverse criticism on Marten's and Zordrager's accounts, that figures by the latter of *B. franche* are really better than any other extant to-day, excepting, perhaps, Capt. Scammon's late drawing. It is quite evident that they were drawn from the fresh animal by an artist, and etched on copper in a style diversified by pleasing artistic accessories. The proportions are well shown, and the baleen accurately exhibited, with the exception that it has the appearance of being continuous over the symphysis of the maxillaries.

We see in these several errors adequate cause for misapprehension, and may not, perhaps, greatly wonder that most authors since Cuvier's day up to within a few years, have ignored a "*Second Species.*"

It is seen that through certain untoward circumstances a well defined and somewhat widely known species of Right Whale had not only come to be denied its place in the Atlantic fauna, but had been well nigh lost to science.

In our search for a complete history of the "*Second Sorte*," so quaintly alluded to by one or more of our ancient authors, we find that the earliest record bearing mention of the Right Whale is

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that of *Orosius Voyages*,[7], written by Alfred the Great in A. D. 890.

In the 12th century an old Icelandic clergyman published in *Konigspeil* (Mirror of Royalty),[8] a list of Cetacea, in which the " Nordcaper " is enumerated as a " Second Species."

It is thought to be doubtful whether the Basques possessed any records of the Whale fishery. The old writer in *Konigspeil* refers to " *Sletbag*," which means a Whale without a fin on its back. " It is almost as big in the body as the last mentioned (*B. mysticetus*), but those who travel much on the sea fear it, as its nature is to play much with vessels." This reference indicates a characteristic which is noticed by all subsequent writers on the subject. His description of the North Whale (*B. mysticetus*) is very accurate; and he adds, absurdly: " It is said not to take any other food than the fog and the rain, and what falls from the air on the surface of the water."

In 1553 Belonius[9] described the whalebone known in his day as eight feet in length, and absurdly refers to its uses as eyebrows.

Bartolini[10] in 16— printed, at the suggestion of an Icelandic priest, a list of Cetaceans. From it is gathered that the "*Sletbag*" is the Whale caught near the shores of Iceland by the French and Spanish sailors, and that it was very different from the North Whale. This account was accompanied by drawings of all Cetaceans then known. Most unfortunately these were lost.

In 1671 Martens,[4] a Hamburg surgeon, issued figures of the "*Second Species*," and speaks of those of the North Cape being not so large as the others (Greenland species); and that they are more fleet and more dangerous. He designates the species as "Nordcaper." This author, it will be remembered, is the one criticised by Cuvier.

In 1624, Schonevelde[11] introduced the name "*Sarde*" as a designation of the "Second Species." This is the earliest mention of this term we have met with.

An important record is that of one John Smith in his "Annals of Salem, Mass."[12] He says: "The whaling business began on the New England coast prior to 1614, guarantied by royal authority to Massachusetts Bay."

In 1625 Purchas[13] refers to the Bearded Whale (*B. mysticetus*) and the "*Sarda*." The same author later alludes to a "*Grand*

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Bay Whale," so called because the first were captured in that locality in Newfoundland. The "*Sarda*" and "*Grand Bay Whale*" are regarded as identical and one with "*Nordcaper*."

In certain directions given to Mr. Edge in 1611, regarding his whaling projects, published in Purchas,[13] the "*Sarde*" is mentioned as follows: "The second sorte is called "*Sarda*," of the same color and fashion as the other (*B. mysticetus*), but somewhat lesser, and the finnes [baleen] not above one fathom long."

In 1690, according to Smith's Annals,[12] "Whales were occasionally killed in Cape Cod harbor. Nantucket first sent boats from shore this year; and in 1700 they began to fit out small vessels to whale out in the deep sea. In 1712 small vessels were sent to Newfoundland and southward along the Gulf. In 1748 whales became so scarce that they were pursued in larger vessels, an hundred sail being sent out from Boston alone."

New Bedford first commenced the whaling business in 1755; their boats going as far south as the Capes of Virginia.

In 1770 the business had culminated. Much larger vessels were now required, and sent across the ocean.

In 1760 some vessels from Sag Harbor voyaged to high northern latitudes, the Right Whale being now exceedingly scarce in the temperate latitudes.

In 1719 the Hon. Paul Dudley, F. R. S.,[14] prepard an essay for the Philosophical Transactions of London, in which he says: "Our New England people used to kill the Whale near the shore, but now go off to the sea in sloops and whaleboats, in the months of June, July, August, between Cape Cod and Bermuda, where they lie up at night." In this essay the important statement is made that the "baleen sometimes attains the length of six or seven feet. Thus by the latter the species is clearly indicated as distinct from *mysticetus*.

Pontoppidan[15] records a similar statement concerning the length of the baleen, and the species was called an "East Coast Whale;" that "it was different in shape of its body from the Greenland species, having as it were a hump on its neck behind, and that the whalebone was much thicker."

About the middle of the 18th century was published a Danish work,[16] which gives a figure of the "*Sletbag*" being hunted by Basques.

In 1740 Klein[24] in his *Historiæ Piscium Naturalis, &c.*, fairly introduces the "Second Species" to science, and adopts it as *Balæna glacialis*, or "Ice fish." He also introduces three other varieties: the "West Fish," ("*B. occidentalis*,") "Northcaper," ("*B. borealis*,") and "Weis Fish" (*B. albicans*). Klein's work is profusely illustrated with large and expensive copper plate etchings of fishes, and some anatomical parts, but has no figure of the "Second Species."

In 1746 Linneus[17] enumerated the *B. mysticetus*, but ignores the other Right Whales.

Anderson,[18] in 1771, describes the "*Sletbag*" "with baleen coarse, brittle and fragile."

Egede[19] mentions an "east coast whale" with "baleen five feet in length." The five foot baleen so frequently mentioned by these old authors, being so strikingly in contrast with the twelve or fifteen foot bone of *mysticetus*, clearly indicates a "Second Species."

Chamisso[20] presents a series of figures from models made in wood by native Aleutians—"*Exactissimus iconibus ternis, a latere, a dorso, a ventre, ad amussim adumbratus*"—one of which represents the several characteristic features of the "Second Species."

In 1782, M. St. Johns[21] writing from New England, mentions a Right Whale, or "Seven-foot-bone-Whale;" fairly indicating the "Second Species."

In 1789, L'Abbe Bonaterre[22] published a copper-plate etching of *B. franche* of great size, which is evidently a copy of that of the older authors. He also describes "Nordcaper" at length; and adds that in Norway it is called "Sildqual" and "Lilie Hual." The latter term literally means Little Whale, which is in accordance with facts, the species being constantly referred to as smaller than the *mysticetus*.

Hans Egede[19] records two forms; the second he calls "North Caper," from its place of abode, the North Cape of Norway. He also names the baleen "barders."

Brisson,[23] in 1762, following Klein, enumerates a long list of synonyms of *B. mysticetus*, and introduces "*B. islandica*," "*La baleine du Islande*," synonymous with "Nordcaper," ("*B. glacialis*,") Klein.

Willoughby[42] ignores the "Second Species."

Pallas[43] quotes in *Zoo. Rossica Asiat.* the *B. culammak* of Chamisso.

Schlegel,[44] Schreber,[45] Wagner,[46] Van der Hoeven,[47] and Siebel,[48] each introduce the "Nordcaper" as a second species.

The foregoing citations represent pretty fully the history of a second form of Right Whale as it stood at the time of Cuvier.

In "*Regne Animal*" of this author, edition of 1817, as we have seen, the "Nordcaper" was introduced; and in a subsequent work, 1823, he rejected it, regarding the matter satisfactorily settled, adversely to the existence of a second form of Right Whale in the North Atlantic.

In a memoir published by M. De Seibold[27] in "*Fauna Japonica*," plates 28–29, are figured two views of a Whale which he denominates *La baleine des mere Australis* (*Balæna antarctica*). This is said to inhabit the waters of the coast of Japan. M. De Seibold procured a model of this Whale in porcelain, the work being done under his own supervision from a fresh specimen by an experienced whaler captain.

The author adds: "It is after this model that our figures have been copied. The great exactness which is known to characterize the Japanese, may be regarded as giving credit to the correctness of the model. It is evident on comparison with Scoresby's figure that there are two species, and that this belongs to the Australian Seas, observed at the Cape by Delalande, and of which the skeleton has been described by Cuvier under the name of Cape Whale."

The author alludes to the fact that this Whale is subject to cirripeds, and is tinted with white on portions of the head. "Characters," he says, "that exist on our Japanese specimen."

Desmoulins,[28] in *Dic. Class. Hist. Naturelle*, Tome II, p. 161, asserts, according to Delalande: "The Cape Whale presents a head more depressed than that of the Arctic Seas. The pectoral fins are longer and terminate more pointedly. The lobes of the tail are separated by a deeper slope, and the color is a uniform black." "We recognize," says M. De Seibold, "in our Japanese specimen all of these characters with the exception of the last, which is of little moment. The great breadth between the region of the eyes, a larger mouth, but above all because the margin of the upper jaw curves towards the eyes strongly below and outwards, these prove the identity of this and the Cape species. The diameter from one eye to another is much more considerable, and there is on the muzzle a strong prominence.

The line which determines the border of the upper jaw is, towards the extremity, a little less curved than in the Arctic; behind, on the contrary, it forms a curve extremely strong, and so directed below and backwards as to recurve just behind the eye. The line of the under jaw presents a different curve; its horizontal part is much shorter than in the Arctic Whale, and before inclines insensibly towards the extremity of the jaw instead of descending abruptly, as in the last species. The baleen appears to be a little shorter than that in the arctic species. The pectorals are longer and are more prolonged in point. The lobes of the tail are separated by a curve much less deep also, and there are a few white spots on the belly."

In the figure of the *B. antarctica* is the first example we have seen of a drawing of the peculiar prominence of the snout so eminently characteristic of the "Second Species." Although this figure is said to have been taken from a model in porcelain, it is much more important and correct probably than some authors would seem to regard it.

The drawing has every appearance of having been done from the carcass or some medium that bore accurately the characteristics. The pectorals and flukes of the tail are evidently too bulky, and the "small" of the body has possibly too great a diameter, but the head is well done. The whole figure is so nearly like ours of Plate X, that it might well have been intended for the same species.

The Aleutian figure of Chamisso has a globular process on the snout, which is probably an imperfect representation of the nasal prominence.

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The Count de La Cepede[8] in his *Histoire Naturelle des Cétacées* presents figures of "Nordcaper," which he asserts were obtained from Sir Joseph Banks, just before the publication of his work in 1804, with the information that he obtained them from Greenland, where they were drawn by one Backstrom in 1779. The latter, it appears, was a sailor in one of the northern ships. Of five editions of La Cepede before us, the figure of "Nordcaper" is found in three only. The text of the subject is, however, in each. In the quarto edition, the figures are imperfect, having no tails, and appear to have been drawn from wooden models. In the edition of 1826, edited by M. Demarest, the same figures occur, with the caudal extremities entire. Both exhibit the characteristic abrupt recurving of the *rictus*, before and under the eye; but no appearance of a protuberance is visible on the snout. The figures on Plate II very well represent the *mysticetus*, though intended for views of "Nordcaper."

An English work on whales, by Dewhurst,[29] copies La Cepede's figures of "Nordcaper;" adding the absurd obliquity to the eye. The figure given in this work of *mysticetus* is not better than those of the ancient authors. Most of the engravings are disgracefully incorrect and ancient.

Another English work on Zoölogy, lately published, perpetuates Scoresby's effigy. Brehm's great work also bears a full page of excellent wood engraving to represent the species and its surroundings, wherein Scoresby's figure is but too apparent.

Harlan's *Fauna Americana*,[30] 1825, recognizes "Nordcaper" (*B. glacialis*, Klein) and *B. islandica* as a synonym.

Godman[31] gives a lengthy account of the *mysticetus*, with an amount of anatomical and physiological knowledge on the subject quite unusual; but he ignores, strangely enough, a "Second Species."

Desmarest,[32] in 1820, treats of the "Nordcaper" (*B. glacialis*, Klein) with *B. islandica*, Brisson, as synonym.

Col. Hamilton, in Jardine's Naturalist's Library,[33] while treating exhaustively of whales of the British waters, unaccountably omits any consideration of a second species. His figures of *B. mysticetus* are evidently constructed on the model of Scoresby's.

Gray[34] in his Catalogue for 1850 presents "Nordcaper" as a synonym of *B. mysticetus*, and the several forms named by Klein as referring to " Nordcaper " he gives similar relationship.

In this edition of Gray's Catalogue is a figure, in lithography, which was evidently drawn from a fresh animal. It is labeled simply *Balæna*, and like others on the plate is used to serve as a generic form. Now this figure can scarcely have been appreciated by the author, as it is an excellent example of the several peculiar characters of the "Second Species," and not at all like the typical form *B. mysticetus*. The author does not describe this figure, nor is there any mention made of it further than that it is a *Balæna*. It *is* a Second Species, or positively it is not the first. It exhibits the head as one-fourth the length of the body ; it has the recurved *rictus* and slender body, with spiracles situated directly over the eyes, all presenting a group of characters clearly recognized as peculiar to the "Second Species."

To complete the exhibit of characteristic features, we find on Plate 2 a figure of a cranium entitled *Balæna*, which shows a black outline to indicate the fleshy portions in place. This sketch shows the almost perpendicular position of the posterior aspect of the maxillary, but, also, a perfect outline in profile of the nasal " bonnet " or protuberance. In short the whole cranium with its external appendages, as well as the former figure on Plate 1, all without doubt were drawn from one and the same, a fresh example of a Right Whale differing essentially from the Arctic form. Indeed, instead of being as Gray intended, a type figure of *Balæna*, it exhibits many of the essential features of Gray's *Eubalæna*. It is evident that the latter author has been influenced by Scoresby's figures, as, had he kept in mind the comparative size of parts in the two species, such errors as are seen in this edition would not have occurred. It is not strange then that he here ignores the " Nordcaper," claiming it as synonymous with *mysticetus*.

In Gray's Supplement to the Catalogue, &c., 1871, the following are recorded :

1. *B. mysticetus*.
2. *B. mediterranea*, Gray. Annals and Mag., N. H., 1870.

Syn. *B. biscayensis* (part) Van Benedin, Osteog. Cet., tab. 7, fig. 1, (animal) Hab. Mediterranean.

3. *B. angulata*, variety of *mysticetus*, Gray (ear bones).

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4. *B. nordcaper*, Bonnaterre.
5. *B. nordcaper*, Brisson.

Syn. *B. biscayensis*, Eschricht.

B. mysticetus, var. Brown. Proc. Zoo. Soc., 1868. Hab. Iceland; called "Sletbag."

Gray quotes from Brown, enumerating all the important characters which so clearly separate the species, and thus at last seems clearly to identify the second species of North American Right Whale as such. He also adds Cope's variety of *mysticetus*, the "Bow-Head" of Scammon's book; and *B. kuliomock* of Chamisso, known only from the wooden model made by Aleutians.

Eschricht and Reinhardt,[6] in an exhaustive memoir on the Greenland Whale, recognize a second species of Right Whale. The essay of Paul Dudley[14] is alluded to by them as one of the early and reliable evidences of its existence in the temperate Atlantic.

Belonius[9] describes a whalebone or baleen, which the authors regard as applying to this form. They also review the directions given to Edge in 1611, in which two species of Right Whale are distinctly indicated: the "Bearded" and "Sarda." Certain inquiries lead the authors to decide that the Arctic Whale (*mysticetus*) could not have been known to Europeans before the sixteenth century; or rather, that as late as the sixteenth century it was unknown to them, with the exception of the Norwegian settlers in Iceland and Greenland. It is said that the descriptions in "*Konigspeil*," 12th century, are the first after Aristotle, and the only ones in the middle ages in which Cetaceans have been described from personal observation. The description of the Greenland Whale is better than some later.

Eschricht and Reinhart,[6] alluding to these figures, say: "We must confess that, as to proportion, we confide more in these drawings" (referring now especially to Martens[4]) "than Scoresby's, which certainly represents the Greenland Whale (*B. mysticetus*) as more slender than it really is."

The authors continue in relation to the existence of a second form of Right Whale, and assert that "it may be said to be so certain that it is much more surprising that it ever should have been omitted in the zoölogical system, than that it has now, as we hope, regained its place in it. The reasons why Scoresby, and afterwards Cuvier, would not acknowledge it as a separate species, were because an insufficient knowledge of its history, partly the fact of the former not having seen anything of it in his whaling expeditions, and partly the great resemblance to the Greenland Whale so evidently seen in the only picture given in the "Nordcaper."

The authors now come to the question, to what species does this "Nordcaper" truly belong, or to what is it most closely allied by its entire structure.

Since Cuvier had established the "Cape Whale" (*B. australis*), habitat Cape of Good Hope, as distinct from the *mysticetus*, nearly all authors agree in referring all Southern Right Whales to this group (or species in some instances). The authors say: "The 'Nordcaper' is to be placed in the group with the Southern Whales; but it is not likely to prove identical with either, not even with the *Baleine du Cap*. But when we consider it to be different from the latter, it is more on account of the common laws affecting the geographical distribution of animals, than because the scanty information we have about the 'Nordcaper' contains anything that positively contradicts the contrary supposition."

They refer to the "Nordcaper" as being nearly extinct since the close of the last century; but that the species is not now infrequent on the coast of the New England States.

Pontoppidan[39] states that the whalers were instructed to seek the "Nordcaper" when circumstances did not favor their hunting the North Whale; and he adds: "The American whalers occasionally caught the 'Nordcaper' in Brede Fiord and Taxe Bay, in Iceland."

In 1854 a Right Whale, accompanied by its young, appeared in the Bay of Biscay. The cub only was caught, and its skeleton was carried to Pampeluna. A lithograph was executed of this under direction of Dr. Monedero. The head presents the same relative proportion to the body as seen in "Nordcaper," and the same inflection of upper lip. The authors, Eschricht and Reinhart, agree that it corresponds to the "Nordcaper," and is undoubtedly the same. They add: "Our researches have determined the fact that the 'Nordcaper' is a distinct species from any of the Southern Sea forms, though belonging to the same group.

In 1865 Professor Cope,[49] we have seen, introduces the "Second Species" fairly to notice as a *re-discovery*, when the fact becomes clearly patent that a form of Right Whale had been abundant on the coast of North America in temperate waters; that it became through well known causes extremely uncommon; that it never was recognized by science; and that during a long period succeeding the abandonment of its capture in our waters the species has multiplied, and is now reclaiming its original habitat.

It seems well established that this is the same as described by Dudley in Philosophical Transactions of London, and, as we have seen, authors pretty well agree that it is "Nordcaper," or the "Second Sorte" of old authors, and probably *B. biscayensis* of Eschricht.

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*The Library of the New York Academy of Sciences occupies a portion of the Library rooms of the Museum.

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ARTICLE VII.—*Notice of some new species of Primordial Fossils in the Collections of the Museum, and corrections of previously described species.* By R. P. WHITFIELD.

Several of the fossils noticed in this paper were donated to the Museum by Prof. Jules Marcou, of Cambridge, Mass., in whose

ERRATA.

Pages 123-134.—For Zordrager read Zorgdrager. For Hefchreibung read Beschreibung. For Groenlanifchen read Gronlandischen.

Pages 124-135.—For Schondevelde read Schonevelde.

Page 126.—For Bonaterre read Bonnaterre.

Page 134.—For Belonius, De Aquatibus, read Bellonii, De Aquatalibus.

Page 135.—For Icthyologia read Ichthyologia, and for Ivan Paul read Hon. Paul. For Islande Hralfishekjon read Islandiske Hvalfiske Kjön. For Kamschatici read Kamtschatici. For Willaughbeii read Willoughbeii. For Spilegica read Spilegicia. For misscellanea read miscellanea. For Desmoulens read Desmoulins.

Page 136.—For Hual og Robbe fangst udi Stadt Davis read Hval-og Robbefangsten udi Strat-Davis. For Abbandlung, a. d. Gebiste, read Abhandlung, a. d. Gebiete.

Pages 136-137.—For mammaloqie read mammalogie. For Langthiere read Saugethiere. For Fortgestzt read Fortgesetzt. For Es-langen read Erlangen. For Handbuck read Handbuch. For Geibel read Giebel. For Pisibus read Piscibus. For Lipsiac read Lipsiæ.

I might remark, that any new material, however meagre, from the primordial zone of the New York rocks, or those immediately adjoining, appears of the utmost importance, in the light of the recent discussions which have taken place concerning the synchronism of the Western Potsdam with that of New York and other Atlantic border localities. It appears to me, that until we know more palæontologically of the New York Potsdam, it is entirely premature to refer it to a different geological horizon from that of either of the other Atlantic regions, or the Western areas. To be sure we have the *Paradoxides* type of trilobite in the Massachusetts and New Brunswick localities, in which respect they differ from those of New York or Wisconsin; but, I think, too much stress has been laid upon this fact. The existence of a given type of life at, or its absence from a certain region, where the conditions of life have been conspicuously different, may have depended more on those conditions than upon a difference in time, and so far as I am aware, the occurence of *Paradoxides* is almost entirely confined

[*Feb.* 13*th*, 1884.]

ARTICLE VII.—*Notice of some new species of Primordial Fossils in the Collections of the Museum, and corrections of previously described species.* By R. P. WHITFIELD.

Several of the fossils noticed in this paper were donated to the Museum by Prof. Jules Marcou, of Cambridge, Mass., in whose possession they have been for many years, having been collected by himself during his visits to the localities from which they were obtained, many years ago.

Others were obtained from Prof. C. H. Hitchcock, in exchange; and those from the Potsdam sandstone of the Ausable Chasm at Keesville, N. Y., were collected by the writer in the autumn of 1880. Of the species of *Olenellus* previously described, the specimens now in the collection present additional features in the direction of the original description, by the author of the species, or variations from these features to so great an extent, that it appears desirable that these should be illustrated and described. More especially is this the case as both the original types and the more recently obtained examples are placed side by side in the Collections of the Museum.

As an excuse for publishing the other new material presented, I might remark, that any new material, however meagre, from the primordial zone of the New York rocks, or those immediately adjoining, appears of the utmost importance, in the light of the recent discussions which have taken place concerning the synchronism of the Western Potsdam with that of New York and other Atlantic border localities. It appears to me, that until we know more palæontologically of the New York Potsdam, it is entirely premature to refer it to a different geological horizon from that of either of the other Atlantic regions, or the Western areas. To be sure we have the *Paradoxides* type of trilobite in the Massachusetts and New Brunswick localities, in which respect they differ from those of New York or Wisconsin ; but, I think, too much stress has been laid upon this fact. The existence of a given type of life at, or its absence from a certain region, where the conditions of life have been conspicuously different, may have depended more on those conditions than upon a difference in time, and so far as I am aware, the occurence of *Paradoxides* is almost entirely confined

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to shaly or limestone formations, and is seldom or never noticed in sandstone deposits like those of the New York or Wisconsin Potsdam. This, I think, is a circumstance which has not been sufficiently considered in the assignment of the several regions to geological horizons.

If we leave out of the question the occurrence of *Paradoxides* from the fauna of the New Brunswick area, for instance, we shall find that its facies will be no older than that of the Wisconsin lower beds, for the same type of *Conocephalites* occurs in each; and, if we consider the Brachiopods, especially the occurrence of *Orthis Billingsi* and *Discina Acadica*, Hartt, both of which would be much newer in type than any forms known to exist in the fauna of Wisconsin. But about the existence of *Discina* I am greatly in doubt. An example referred to *D. Acadica*, received from Mr. G. F. Matthews, I believe to be only the imprint of a univalve shell, either of the genus *Palæacmaea* or *Stenotheca*. It certainly is not a *Discina*. This would still further show the relations of the New Brunswick beds with the New York and Wisconsin localities, as both of those genera are known from the former, and *Palæacmaea* from the latter. The occurrence of *Orthisina orientalis* herein described, at the Georgia, Vt., locality—which species is so close a representative of *Orthisini pepina*, Hall, from the Trempaleau, Wis., and Lake Pepin, Minn., beds, that I am not sure but that I err in giving it a distinct name—still further connects these Atlantic areas with the Western ones. My own impression, at the present time is, that the New York typical Potsdam is about equivalent to the lower portion of the Wisconsin areas, and that the Acadian beds of Canada and Vermont, and perhaps the other Atlantic areas, are not appreciably different in age, but that the difference in faunæ is more the result of conditions upon which life depended than a difference in time. I am also of the opinion, that much of the so-called Quebec of Canada, and especially the lower limestones at Point Lévis, are typical Potsdam. At least, if the trilobitic fauna of these limestones were shown me, without a knowledge of their locality, I should unhesitatingly pronounce them Potsdam. It may be, that at some of the localities, the shales bearing Paradoxides-like trilobites may be overlaid by sandstones; but have we anywhere this succession, at any one locality, where the rocks bear the respective faunæ which have been supposed to be characteristic of the two distinct epochs? Until such can be shown to be the case, with some evidence of a physical break representing a lapse of considerable time, I can see no absolute reason for assigning the sandstone to a different geological epoch from that which is assigned to the shales, simply because one contains a single form of life which may not have been suited to the conditions which existed during the formation of the deposit.

Genus LINGULEPIS, *Hall.*

Lingulepis minima, n. sp.; **Plate 14, Figs. 1 and 2.**

Shell small but slightly exceeding one-fourth of an inch in length measured on the ventral valve of the largest examples seen. Cuneiform in outline, less than two-thirds as wide below as the entire length, attenuated and elongated at the beak on the ventral side, and elongate-ovate on the dorsal side. Lateral margins of the ventral valve regularly diverging and direct, while the basal or front margin is broadly rounded with subangular lateral angles. Dorsal valve shorter than the ventral and more rapidly diverging in the upper part. Disc of the valves convex, the ventral side becoming angularly so in the narrower portions, while the dorsal is most convex near the umbone; surface smooth or semi-polished when perfect, and marked by very fine concentric lines of growth, and in the partially exfoliated condition, the usual state, they show strong radii.

This is a small species, and so far as I am aware, the smallest of the genus described from this country. It will be readily recognized by the sharply wedge-form outline, and the broadly-rounded front margin. The species most nearly related to it is *L. cuneolus*, Whitf., from the Potsdam sandstone of the Black Hills (see Geol. Black Hills of Dakota, p. 336, pl. 2, fig. 5 and 6), from which it differs in its more attenuated form, straight lateral margins and less rounded front.

Formation and locality.—In the Potsdam sandstone at the Chasm near Keesville, N. Y., where it occurs associated with *Conocephalites verrucosus*, herein described.

Genus OBOLELLA, *Billings.*

Obolella prima, Conrad sp.; **Plate 14, Figs. 3–5.**

Lingula prima (Conrad), Hall; *Pal. N. Y., Vol* 1, *p.* 3, *pl.* 1, *fig.* 2.
Lingula ovata (Emmons); *Geol. Rpt. 2d Dist. N. Y. p.* 105.
Lingula prima (Emmons); *Am. Geol. Vol.* 1, *p.* 202.
Lingulepis prima (Conrad); Miller; *Cat. Pal. Fossils, p.* 115.
Obolella nitida (Ford); *Am. Jour. Sci.* 1873, *p.* 213.
Obolella? polita (Hall); 16*th Rept. N. Y. State Cab. p.* 133, *pl.* 6, *figs.* 17–22.

The shells of this species as found in the Potsdam sandstone at the Ausable Chasm, near Keesville, N. Y., are usually in a very poor state of preservation, and do not afford very good means of comparison with other species. The matrix in which they are preserved is a hard quartz sandstone, with a silicious cement, which does not separate readily from the shell, but causes a complete exfoliation of the surface when broken; moreover, the grains of sand have usually left their imprint on the shells so as to further obscure their form. During a visit to the Chasm in 1880, I obtained shells preserved in a much better condition than are those in the well-known Lingula bed at the foot of the Cathedral rocks. In this layer, although the specimens are somewhat smaller in size, the shell is often perfectly preserved and possesses a high polish on its surface and are in a good condition for comparison with other species. In making comparisons between the New York form and *Obolella polita* of the Wisconsin rocks, I can find not the least particle of difference between individuals of the same size. In size, form, convexity, structure of surface, and all other external characteristics, they present precisely the same aspect, except in the condition of preservation, which of course has no bearing on specific relationship. Therefore, I unhesitatingly pronounce them one and the same species.

I have long been under the impression that *Obolella chromatica*, Billings, from the Potsdam horizon in Canada, would prove to be identical with the New York species, if we should obtain the latter in an available condition for comparison. I therefore applied to Mr. J. F. Whiteaves, of the Geol. Survey of Canada, for the loan of authentic specimens of that species, and of *O. Ida*, of the

Quebec group. *Obolella chromatica* proves to be distinct, as the specimens show features which the figures do not, and features which do not exist on any of the individuals of *O. prima* which I have seen, namely, a truncation or straightening of the basal or front margin, and a broad, shallow depression of the median portion of each valve; the New York examples of *O. prima* being regularly convex on the surface in the lower part, with a regularly rounded front margin. *O. chromatica*, as preserved in the Canadian limestones, presents a dull surface, not polished like the New York species, or those from Trempaleau, Wis., when in a perfect state of preservation. In comparing the original of *Obolella Ida*, Billings, there appears to be no distinction between them. The specimen used is slightly exfoliated, but in form, convexity and general appearance, there is no difference ; and, so far as the shells themselves are concerned, they might with perfect propriety be considered as of the same species. The only objection being the supposed difference in geological position. Mr. Billings says, under the description of this species, that it occurs in limestones Nos. 1 and 3 of the Quebec group, at Point Lévis, Canada ; while on p. 862 of the Geol. Report of Canada for 1863, it is assigned to limestones 3 and 4. It is my impression, however, that the true stratigraphical relations of these limestones is not satisfactorily determined, if we judge by their fossil contents. If we look at the illustrations of the trilobites credited to limestone No. 3 of the Point Lévis section, on the page of the work cited above, one cannot fail to be impressed with their primordial aspect, and if I were shown such trilobites from any other locality, I should not hesitate to pronounce them as from the Potsdam horizon. This primordial aspect of these beds has been fully recognized in the above-mentioned report on p. 293.

In comparing these Ausable specimens with specimens from the limestones at Troy, N. Y., identified by Mr. S. W. Ford as his *Obolella nitida*, I find there is a very close resemblance. It may be that the examples referred to are wrongly identified, but they were determined by himself. The examples do not accord very well with the description, as they are as long as wide, or even a little longer than wide, and appear ovate instead of " transversely sub-oval," and there is no appearance of a hinge line which is "apparently equal to about one-third the width of the shell," which would be a somewhat anomalous feature for a shell of this genus. The shells in question scarcely differ in any respect, not even in size, from those in the sandstone, and I see no reason whatever for considering them as distinct.

Genus ORTHISINA, *D'Orb.*

Orthisina orientalis, n. sp.; **Plate 14, Fig. 6.**

Shell quadrangular in outline, somewhat higher than wide, with vertical and sub-parallel lateral margins, and broadly rounded base. Cardinal line rapidly sloping from the apex to the extremities, which are slightly rounded. Hinge line straight, as long as the greatest width of the shell. Cardinal area broad and high, divided in the middle by a triangular foramen which is about as high as wide. Surface of the ventral valve moderately convex, marked by very fine radiating striæ and also by several concentric lines of growth. Filling of the rostral cavity and foramen large and prominent. Specimen, a cast in shale, of the ventral valve only.

This species is very closely allied to, and may possibly be identical with *Orthisina Pepina* (*Orthis pepina*, Hall) from the Potsdam sandstones at Kickapoo and Trempaleau, Wis., and Lake Pepin, Minn. The present example described is somewhat larger than any specimen which I have seen from the Western localities, and is more finely striated. The specimen is preserved in a partially metamorphosed shale, and has undergone some compression so as to render it less ventricose than it probably was during life.

Formation and locality.—From the shales holding *Olenellus Thompsoni*, Parker's farm, West Georgia, Vt. Collected and presented to the Museum by Prof. Jules Marcou.

Genus NOTHOZOE, *Barrande.*

Nothozoe Vermontana, n. sp.; **Plate 14, Figs. 14 and 15.**

In some white sandstone of the Potsdam, associated with *Hyolithes gibbosus*, H. & W., are great numbers of elliptical or oval bodies which are irregularly convex on the surface, varying from an eighth of an inch to fully three-fourths of an inch in length and about three-fifths as wide as long. The specimens are all internal casts or impressions, and have a highly ferruginous appearance when on a freshly broken surface of the rock. They are usually a little more convex at one end, and along one side of a median line than on other parts, and present much the appearance of an overgrown *Leperditia.* These bodies I have supposed to be the remains of a bivalve crustacean, as they correspond quite closely with figures of species of the genus *Nothozoe*, Barrande. I therefore propose to class them under that genus, with the specific name *Vermontana*, with the following diagnosis :

Cast of carapace valves oval or ovate, convex on the surface, most convex near one end and along one side, midway between the margin and the median line. Surface features not definitely known, but probably radiately striate, from the most convex part outward.

On a weathered surface, where there are numbers of the impressions, there are faint indications of fine radiating striations as distinct as could be expected when preserved in a coarse sandstone or quartzite matrix. The striations are hair-like and appear to diverge from the most convex portions across the valves. Neither margin is straight, although one side often appears straighter than the other, though it is not uniform with the convex parts. No tubercles or features of a like character have been observed.

In general appearance the specimens, as seen on the rock surface, resemble a group of small Lamellibranchiate shells, and would naturally be looked upon as such, and are usually arranged on the surface of the rock with their longitudinal axis parallel to each other, as would be the case with such shells under the action of a current of water.

Formation and locality.—In white sandstones of the Potsdam formation. The specimens bear labels "Highgate, Vt., C. B. Adams," but Prof. C. H. Hitchcock tells me they are from Lake Dunmore, near Middlebury, Vt., that no such rock occurs at Highgate.

Genus CONOCEPHALITES, *Zenker.*

Conocephalites verrucosus, n. sp.; **Plate 14, Figs. 9-12.**

Minute, the largest example seen indicating not more than a length of an eighth of an inch for the entire cephalic shield.

Glabella and fixed cheeks when united, subquadrate in outline and quite convex, narrowest across the front and gradually widening behind. Anterior margin rounded and bordered by a thickened projecting rim, which is wider in the middle than toward the facial sutures. Fixed cheeks moderately wide but highly convex, crossed at about their anterior third by strong, elevated, rounded ocular ridges, which are curved outward in their direction. Dorsal furrows deeply marked. Occipital ring narrow but sharply rounded. Glabella paraboloid, narrowed anteriorly but not truncate, higher than wide, highly convex and marked by three pairs of deeply impressed glabellar furrows. Occipital ring of the axial portion elevated and projected backward in form of an elevated and pointed node, or sub-spine. Middle of the frontal limb divided by a shallow depression, and the surfaces on each side raised in the middle so as to appear sub-tumid. Surface of the test entirely and closely covered with fine, raised granules, very distinct under a hand-glass of ordinary power.

Movable cheeks only partially known. The fragments observed would indicate a rather narrow plate, moderately elevated, much longer than wide, curved on the outer margin and bordered by a strong, elevated and rounded marginal rim, which is continued backwards so as to form a strong spine of unknown length at the genal angles. Surface characters as on the head.

Pygidium transversely elliptical, with acute outer angles, bordered by a narrow but very distinct marginal rim; proportions of length and breadth about as three to five, the posterior margin more convex than the anterior. Axial lobe narrower than the lateral ones, highly convex, extending nearly to the posterior margin of the plate, marked by four distinct annulations besides the terminal one, which is confluent with the marginal rim. Lateral lobes divided into four distinct annulations, which terminate at the marginal rim, each annulation marked along the middle by a narrow depressed furrow making them double. Surface entirely covered by the same form of minute granules as the middle parts of the head and movable cheek.

This small *Conocephalites* is very closely allied to *C. minutus*, Bradley, and is of corresponding size. It differs somewhat in its form and proportions, especially so in the middle portions of the head, having narrower fixed cheeks and more cornical glabella. The suture line also differs somewhat, especially in being more direct behind the eye, giving a much shorter lateral limb; the frontal limb also differs, particularly in the depression at the middle line. But the most remarkable distinction consists in the roughly granulose surface. This feature is quite remarkable, as the granules are densely crowded over every part of the surface, in the depressions as well as on the elevations. The *C. minutus* does not often preserve the substance of the test, so that the actual surface is not often seen. But in impressions of it where it was preserved in a fine impalpable mud, the matrix is entirely smooth, while this one, even in cases where the matrix is more coarsely sandy than the size of the granules, the peculiar marking is readily detected, both on the glabellas and pygidiæ, in numerous instances.

Formation and locality.—All the specimens of the species yet known I obtained from layers of a white sandstone of the Potsdam, having ferruginous patches filled with *Lingulepis minima* and *Obolella prima*, on the high walk on the left side of the Ausable Chasm, near Keesville, N. Y., as you pass down the stream, a little below the Punch Bowl. This would bring its location fifty or more feet, I think, above the stratum which furnishes the *C. minutus*, which is near the base of Cathedral rocks in the same Chasm.

Genus ARIONELLUS, *Barr.*

Arionellus quadrangularis, n. sp.; **Plate 14, Fig. 8.**

Known only by the glabella and fixed cheeks, which are of small size, and as united are subquadrangular in form and depressed convex. Glabella quadrangular a little narrower in front than at the occipital line, squarely truncate in front and destitute of any appearance of glabellar furrows. Dorsal furrows bounding the glabella, deeply marked. Fixed cheeks about half as wide as the glabella, moderately convex in the middle. Frontal limb about as wide as the fixed cheeks, convex on the surface and strongly arched on the front border; no marginal rim exists. Palpebral lobes, one of which is visible, minute and but slightly raised above the general surface of the fixed cheek adjacent. Occipital ring narrow. General surface smooth.

This species is so entirely distinct in its quadrangular glabella that there is no possibility of confounding it with any other American species of the genus.

Formation and locality.—The locality of this small trilobite, Braintree, Mass., in the paradoxides beds, makes it particularly interesting, and must be my excuse for describing a species from such very imperfect material. So far as I can ascertain it is the only species known from the beds at that locality, beyond the *Paradoxides Harlani.* I have long known of its occurrence there, but have not been able to find any record of its description at any time previously. Presented by Prof. J. Marcou.

Genus ANGELINA, *Salter.*

Angelina Hitchcocki, n. sp.; **Plate 14, Fig. 13.**

Body ovate in outline, largest across the base of the head, and gradually narrowing behind; distinctly trilobed longitudinally.

Head broad, semicircular in outline, being about twice as wide across the base as the extreme length from the front margin to the posterior side of the occipital ring. Glabella proportionally large, with parallel sides and rounded front. Surface convex and apparently destitute of any glabellar furrows. Frontal limb narrow in front of the glabella, and bordered by a narrow rounded rim. Fixed cheeks proportionally broad, crossed in front of the eyes by a distinct ocular ridge, which is curved and runs nearly parallel to the margin of the head. Lateral limbs large, triangular and extending nearly to the origin of the cheek spines. Eyes large, reniform, and the palpebral lobes flattened. Occipital ring narrow and divided from the glabella and fixed cheeks by a narrow groove. Movable cheeks elongate-triangular, curved on the outer margin, moderately convex over the central area, and projected backward at the postero-lateral angles in short spines. Facial suture passing a very little outward in its course from the eye to the anterior margin, which it cuts nearly at right angles to the border; behind the eye it passes obliquely outward and backward with a slight curvature to just within the cheek spine, forming a very broadly triangular lateral limb.

Thorax nearly once and a half as long as the head, consisting of twelve segments, and nearly twice as wide at the anterior as at the posterior end; strongly trilobed, the axial lobe forming one-third of the width anteriorly, but rapidly tapering backward; at the twelfth segment its width does not exceed one-fourth of the whole. Axial lobe convex, the segments well marked, narrow and rounded, separated by broad grooves; pleura straight, direct and flattened for nearly two-thirds of their length, from which point they are rapidly narrowed to a point, which is not recurved, but which is a little back of the central line of the rib. Surface of the pleura broadly channelled, the furrow occupying nearly the entire width of the rib, and extending to the extremity.

Pygidium small, semi-elliptical and transverse, about four times as wide as long, and marked by three furrows, both on the very small axis, and on the lateral areas. Axis terminating within the posterior margin of the plate.

Surface of the test smooth.

The generic relations of this trilobite are not exactly those given by its author to the genus *Angelina*, but they are more nearly like them than of any other described. The general form and proportions are very similar, as is also the general appearance; but in the head parts it differs principally in the possession of very distinct glabellar furrows, which is in direct opposition to the generic diagnosis, and the eyes are larger than those of the typical species. In some lights the specimen figured seems as if it had possessed two pairs of glabellar furrows, but they are so very unsatisfactorily defined, that I have chosen rather to consider them as absent. The great difference, however, is the nature of the furrows of the pleura and the pointed extremities of these parts. In the *A. Sedgwicki* the furrow is narrow at each end, and broadest and angular at the geniculation, which is near the middle of the length, while in this one the furrow is broad at the inner end of the pleura, and retains its breadth and depth for the entire length, only narrowing as the extremities of the ribs are narrowed, while the extremities of the ribs cannot be fairly said to be bent backward to any degree. These points of difference, although considerable, I have not deemed of sufficient importance to constitute a distinct genus, rather considering that the typical species was followed too closely in the original generic description.

Formation and locality.—From the primordial slates at Georgia, Vt. Named in honor of the discoverer, Prof. C. H. Hitchcock.

Genus DIKELLOCEPHALUS, *Owen.*

Dikellocephalus? Marcoui, n. sp.; **Plate 14, Fig. 7.**

This species is only known, as yet, from fragments of the pygidium, but the form is so remarkable for a primordial trilobite, and so distinctive in its characters that it will be readily recognized in other specimens when found, consequently there can be no good reason why it should not be described even from the imperfect material.

The pygidium has been broadly fan-shaped, with a strong central axis and broad convex lateral lobes, form nearly semi-circular, with a moderately convex anterior margin. Axial lobe about two-thirds as wide as each lateral lobe, strongly convex, marked by about nine or possibly ten annulations (seven appearing in the fragment), the anterior three each bearing an elevated node or subspine in the middle, the fourth one having only a low node, the remainder plain. Lateral lobes divided into five or more annulations exclusive of the narrow anterior one, by deep narrow grooves or furrows, which terminate a little within the border; each annulation being marked on its surface by a faint depressed longitudinal line. Outer margin of plate bearing broad flattened spines, which are gently recurved. Five of these spines are seen on the fragment described, the last of which originates opposite the fourth segment, leaving space for two or perhaps three additional ones between it and the central line of the plate. This would give seven or possibly eight spines on each side of the plate. Surface of the plate smooth to the unassisted eye.

This is one of a group of primordial trilobite pygidiæ having affinity with the genus *Dikellocephalus*, Owen; but not properly belonging there. They have been variously placed under several genera, but are equally unlike any of them, and this one is more extreme in its characters than any hitherto described. It strongly reminds one of the pygidiæ of a group of *Dalmania* which characterize the lower Devonian of America, in the arrangement of spines around the outer margin, and is so very similar that were there any question as to its authenticity I should have been inclined to place it at that horizon.

Formation and locality.—The specimen used for description and illustration was collected by Prof. J. Marcou, from the Georgia slates on Parker's farm, near Georgia, Vermont.

Note on **Olenellus Thompsoni**, Hall, *Plate* 15, *Figs.* 1–4.

There are some features of this species which in the light of material lately obtained from Prof. Jules Marcou and from Prof. C. H. Hitchcock, would seem to need revision, and as the types of the species are in the Museum Collections it would appear only proper that the corrections should be founded upon the specimens now placed with them.

In the original figures and description the direction of the facial suture is left in doubt. This feature is usually obscure, and, in fact, in most specimens, all evidence of its existence is entirely wanting, but in one example it is easily traceable on one side of the head. In this case it cuts the anterior margin of the head on a line nearly in front of the outer edge of the palpebral lobe, passing through the rim of the head on a line parallel to the axis of the body. After passing through the rim it curves outward and then inward again to the anterior angle of the eye, forming nearly a semicircle, the curvature being nearly that of the anterior border of the glabella. Behind the eye, visible on both sides of the head, it passes outward and downward at an angle of about forty-five degrees to the base of the head to the posterior margin, forming very short, broadly-triangular lateral limbs. The glabella is very much elongated, is rounded and globuliform in front, and divided by three pairs of furrows, in front of the occipital furrow, the upper two never, and in some cases none of them, extending entirely across. The outer margin of the upper lobes are convex and partially confluent with the palpebral lobe, producing the features to some extent represented in the figures on page 116 of the 13th Rept. State Cab. N. Y.

The most important difference, however, noticed among the more recent collections, is the remarkable length of the pygidium, or rather caudal spine. This part of a specimen somewhat smaller than that figured in the 16th Rept. State Cab., is seen to be two and one-eighth inches long and still imperfect at the extremity, while in several other individuals it can be traced, faintly marked on the shale, to a nearly equal extent. One small individual, only two and a quarter inches across the base of the head, preserves it to a length of one and a half inches. There is not the slightest evidence of any lateral lobe or expansion, or anything analogous to this part as seen on other genera, and the median ridge shown upon the specimen figured as above referred to, does not always exist. On one specimen the fourteenth axial ring looks almost as if it might have formed an anterior lobe or ring of the telson; but in others it is seen to be distinctly separate and articulated, as are the forward axial rings to each other. This feature of the pygidium is so distinctive among all other trilobites, that it alone would serve as a generic distinction, and if the condensation of parts indicates development of organization, this form would appear to be below even paradoxides, and should precede it in age.

Among the collections mentioned above, there are several small specimens which I have been inclined to refer to *O. Vermontana*, H.; none of them, however, are quite as small as the type of that species. On a critical examination of these forms and comparison with the different sizes of *O. Thompsoni* in the Collection, I find that the distinctive features of *O. Vermontana* become less and less marked, and become merged into those of *O. Thompsoni* as the specimens increase in size, and I am inclined to think the two species represent only different stages of growth or development of one form. In the *O. Vermontana* the head is proportionately longer than in the other, and the axial lobe of the thorax supposed to be narrower, while the greater proportional width of the third thoracic segment is the most striking feature. All these features I find become less distinct with increased size, except, perhaps, the proportionate length of the head. This feature varies much at all ages. The great width of the third thoracic

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segment and its angularity at the geniculation is to me the most striking distinction between the two forms; but this is gradually lessened according to size, but is always, even in the most typical *O. Thompsoni*, a marked feature, and on a fragment presented by Prof. Marcou, which measures four and a half inches across the thorax, it is still quite marked, but no one would consider the specimen as anything other than one of *O. Thompsoni*.

On one of these small individuals above mentioned, and which shows only twelve thoracic segments, there is a suture which passes around the front of the head a little within the anterior border, which is probably a feature of the under surface (see pl. 15, fig. 3). It rises from the marginal rim of the head a short distance above the base of the cheek spine on each side and passes upward, gradually diverging from the border until it strikes the front of the glabella, where it more rapidly bends inward near the junction of the two sides, probably to unite with the hypostoma. This suture is clear and distinct, and strongly reminds one of the inner margin of the anterior plate on the under side of the head of a *Limulus*. I have not been able to find this feature on more than the one specimen. One example where the body is folded over the head, and which shows the characteristic form of the third thoracic segment of *O. Vermontana*, shows the pygidial spine to a length of more than one and a quarter inches, the specimen measuring only two and a quarter inches across the base of the head, which is very large for *O. Vermontana*, but small for *O. Thompsoni*.

Genus MACLUREA, *Lesueur*.

Maclurea Wadsworthi, n. sp.; **Plate 14, Fig. 16.**

Shell small, the example used measuring only about five-eighths of an inch in its greatest diameter, and consisting of about three volutions, the inner of which are very slightly raised above the outer ones; while the surface between the sutures is entirely flattened. Outer edge of the volutions very slightly rounded. Concave surface of shell unknown. No striæ are perceptible on the specimen.

The example is a cast in sandstone of the flat side of the shell, and the matrix of the same, preserved in such a manner that the concave surface is entirely concealed, consequently these features are unknown. There can be no question whatever as to its generic relations, however, as they are too well marked to leave any doubt, and it adds another genus to the already extensive fauna of the Western Potsdam.

Formation and locality.—The specimen was collected by Dr. M. E. Wadsworth, of Cambridge, Mass., from the Potsdam sandstone at Mazomanie, Wisconsin, in the summer of 1872, and by him presented to the Museum Collection.

[*Feb. 13th,*

ARTICLE VIII.—*Geological Sections across New Hampshire and Vermont.** By C. H. HITCHCOCK.

THE geological surveys of New Hampshire and Vermont were based upon the measurement and delineation of several geological sections, crossing the formations at nearly right angles to their course, and running east and west. Colored profiles, with the accompanying descriptions, will be found in the geological reports of these two States. Since the completion of these surveys, I have had occasion to go over the ground again; collecting specimens for the illustration of these sections in the rooms of the American Museum of Natural History. These additional explorations have enabled me to correct doubtful points, to confirm truthful representations, to change the section lines where improvement was possible, to take advantage of discoveries made by other observers, and especially to present a connected view of what has been learned concerning the geological succession in the two States. A knowledge of this territory furnishes the key to unlock the mysteries of New England geology, as well as that of the whole of the middle section of the Atlantic geographical area. Profiles drawn to the horizontal scale of one mile to the inch, $\frac{1}{63360}$, and twice as great vertically, and colored to exhibit the variety and order of the formations, have been prepared to accompany the specimens upon the shelves in the cases. In the vicinity there may be seen a large colored geological relief-map of New Hampshire, having the same horizontal scale with the profiles. The sections illustrated are thirteen in number, accompanied by nearly 2200 specimens.

Our object in preparing this sketch is to so record the most important facts connected with our explorations, that those who visit the Museum may have the opportunity to verify our conclusions for themselves by studying the specimens, both lithologically and stratigraphically. The work of exploration was undertaken with the determination to discover what the rocks themselves taught, and not in the interest of any theory. Hence students may rely upon the truthfulness of all the representations. The

* This article was prepared in June, 1882.

specimens come from ledges in the localities indicated, and the positions of the strata are stated according to our best judgment from personal observation. If there is ever any want of symmetry in the folds, if one side of an axis seems to possess an exaggerated thickness, it is because all the facts needed for full delineation are not known. Pains are taken not to represent curves and faults except those whose existence is unquestionable. Hence the inquirer can utilize the ten years of field and office work embodied in these collections, nearly as well as if he had gone over the ground himself. He will also understand for himself the localities where supplementary observations are needed.

About 90,000 feet thickness of strata occur over this territory. As they have not been particularly investigated elsewhere, it follows that many groups must exist not generally recognized, and peculiar designations must be employed, which will be perplexing. To assist the inquirer, I will, at first, present a few general conclusions, based upon a terminology readily understood; reserving the fuller details of our scheme of classification and structure for the sequel, to be fully appreciated only by a painstaking examination of the larger profiles and specimens in the cases.

It should also be borne in mind that our various groups or formations are classified according to stratigraphical reasons, and not lithology. Lithological names may be used for convenience, or so as to avoid the multiplication of local designations. A lithological similarity is useful in tracing a formation from farm to farm, or town to town throughout a county; or to identify the opposite side of a synclinal basin or anticlinal ridge. Furthermore, unlike rocks are never assumed to be identical. If a hornblende schist and clay slate dip towards each other, they are assumed to be of different age and separated by a fault. All the igneous rocks of our field are held to be truly eruptive, and are devoid of marks of stratification. If a granitic rock shows foliation, it is classed among the gneisses. Many speak of "gneiss passing into granite." All such examples are called *gneiss* in our scheme.

The published sections accompanying this bulletin have the horizontal scale of $\frac{1}{300000}$, and the vertical of about $\frac{1}{180000}$. They are arranged geographically correct with reference to each other, and the meridians and longitude are drawn as upon a map. In some cases the extreme east or west ends of the sections are not represented. The base line of all the sections is 1650 feet below tidewater. The exact courses of these section lines are also shown upon an additional plate. Twelve variations of lines, dots and dashes indicate as many groups of rocks upon which our primary conclusions are based. They are: 1. * Niagara group. 2. Upper Cambro-Silurian slates and schists. 3. Cambro-Silurian limestones. 4. The Connecticut Valley mica schists, quartzites, etc., referred to the Coös group in the New Hampshire reports, and the calciferous mica schists of the reports of both States. 5. Potsdam sandstone. 6. Clay slates and argillitic and other schists, supposed to be of Cambrian age. Of these, the "Georgia slates" of the Vermont report contain the *Olenellus* and *Angelina*,† the others have not yet yielded any organism. 7. Mica schist of eastern New Hampshire, a part of the "Rockingham group" of the report. 8. Huronian, including the chloritic, argillitic, dioritic schists, quartzites, and protogenes flanking the Green Mountains, and adjoining the Connecticut River, or the rocks usually referred to this group by authors; also the "Merrimack group," "Ferruginous slates," "Kearsarge group," and part of the "Rockingham group" of the New Hampshire report. 9. Montalban rocks, as defined in the New Hampshire report, including the schists holding the coarse granite veins carrying merchantable mica. 10. Ordinary gneiss, including the "Green Mountain," "Lake Winnipiseogee," and "Bethlehem" varieties of the reports. 11. Porphyritic gneiss. To these may be added another distinction for the unstratified rocks, in which are embraced granite, syenite and porphyry.

THE CAMBRO-SILURIAN.

Probably the whole of this division of the Paleozoic rocks occurs in the Champlain Valley. Sections I.–VII. display a mass of green hydro-mica schists overlying the fossiliferous limestones of this series, and may, perhaps, represent the Loraine slates of New York. On our section lines the Trenton is wanting in immediate contiguity to these schists, so that the question arises

* Formerly regarded as Lower Helderberg, but recently shown by Prof. R. P. Whitfield to belong to the Niagara.—*Am. Sci. Jour.*, III., vol. xxv., p. 368.

† As determined by Prof. R. P. Whitfield, in Bulletin No. 5, vol. 1.

whether these schists may not represent beds that were laid down in the Trenton age. So far as recognized, the Trenton beds are limestones; but there must have been sediments coeval with those limestones in the ancient seas: still it is but a rude conjecture that would refer them to this age. They are called Loraine upon the sections. These beds were called "Magnesian slate" by Prof. Emmons, and constituted the upper member of what he styled "Lower Taconic." The relations of the limestones to the schists are well shown upon section IV. in Mt. Eolus. There about 500 feet of the schists are isolated from all connection with the main range, and rest upon about 2000 feet thickness of limestones, almost horizontal, except at their base. The same schists reappear in what is called the Taconic range of mountains, a few miles west of Mt. Eolus. They universally dip east, and would be regarded as older than the limestones except for the section in Mt. Eolus. This fact has led to careful search at the junction of the two formations for evidence of a fault. Section V. shows this break very plainly, in Tinmouth. Section I. affords the most satisfactory evidence of the passage of the limestones beneath the schists of the Taconic range. At North Pownal a fault has brought up the limestones from beneath the heart of the mountain range. To the east, near the Massachusetts line, the limestones dip west towards these schists, contrary to the nearly universal position of these rocks west of the Hoosac Mountains. By following the Troy and Boston Railroad to the north from North Pownal, we find the limestones nearly or quite continuous to Hoosick Falls, where the characteristic fossils of the Chazy and calciferous sandrock occur in them. This section, therefore, demonstrates the inferior place of the limestones as compared with the schists. This is in the heart of the classic Taconic grounds, where the late Prof. Emmons deduced the conclusions giving rise to the existence of the noted *Taconic system*. I cannot ascertain that he discovered this western dip in Pownal, and the consequent connection, ledge by ledge, of his Stockbridge limestones with the Chazy and calciferous at Hoosick. It is just here that the fatal defect to the establishment of the Taconic system, as defined by Emmons, exists. His paleontological arguments were better than the stratigraphical. Our sections are too small to show the occurrence of the subdivisions of the limestone. Upon VII., according to the late Rev. A. Wing, the following members are recognizable: first, "Hudson River slate," a mile or more west of Middlebury C. H.; second, Trenton, or sparry limestone, without fossils; third, *Rhynchonella* beds, or Chazy, this and the preceding of unusual thickness; fourth, "trilobite bed and conglomerate," the probable equivalent of the Levis limestone of Logan; fifth, the *Ophileta* beds, or calciferous sandrock. These, as our section shows, are followed next by the red Potsdam sandstone of Snake or Grandview Mountain, whose top is in Addison.

The same author has described a section along a part of No. VII., from East Shoreham, through Whiting and Leicester. The "Hudson River slates" are in the centre, dipping east, flanked on both sides successively by the "Trenton and Chazy," calciferous and Potsdam. It is an overturned synclinal, as all the strata dip to the east. Instead of a red sandstone on the west, we find a gray sandstone, having the usual aspect of the Potsdam on the New York side of Lake Champlain. North of Shoreham, the color of this western band is red entirely through the State to Canada, while the eastern range is gray and often vitreous. This is one of the most satisfactory of our sections across the Champlain Valley, as it demonstrates the relations of the different Cambro-Silurian limestones to the Potsdam sandstone.

THE CAMBRIAN.

On the west flank of the Green Mountains, sometimes rising higher than the main range, is a band of quartzite which received from Emmons the appellation of "Granular quartz," and it was made the base of his Taconic system. Our sections show that it immediately underlies the calciferous sandrock, and having fossils similar to those found elsewhere in the Potsdam sandstone, it is clearly a member of the Cambrian series. In some quarters the effort has been made, unsuccessfully, to refer it to the Middle Silurian sandstones. Upon sections III. and VII., besides other localities mentioned in the 1861 report, the basal beds contain pebbles of blue quartz, which are recognized as having been derived from the adjacent gneisses of the Green Mountains. Hence this quartzite has been formed since the elevation of the

Green Mountains above tide water. The calciferous sandrock had its origin posteriorly to the quartzite, and likewise the several other members of the limestone group in their turn, and there is a natural order of succession in time of the formations from the gneiss to the west.

Three bands of sandstone, therefore, are referred to the Potsdam in the Champlain Valley: first, the normal gray sedimentary beds at the foot of the Adirondacks, always known under this name since 1840; second, the quartzite on the flank of the Green Mountains; third, a range of red sandstone and dolomite from the Canada line to Bridport, where it is succeeded by outcrops of a material not distinguishable from the first-named band. Partly accompanying the middle band is a series of slates and hard sandstones, passing into roofing slates, called Georgia group in the State report, which carries such fossils as *Olenellus* and *Angelina*, and is, therefore, thought to be somewhat older than the typical Potsdam sandstone. These are partly connected with a series of schists gradually increasing in thickness and width of territory from section VII., east of Middlebury, to the Canada line. The quartzite first named terminates between sections VII. and VIII., save as it may merge into these schists. The continuation of these schists into Canada is an area partly of Cambrian and partly of Levis age.

We can now understand the physical history of Western Vermont in the early Paleozoic age. The Adirondacks and Green Mountains had been elevated above the sea, and constituted dry land, connecting on the east with the large Atlantic area—Newfoundland to Alabama—and on the northwest with the generally recognized Laurentian of British America. The waves dashing at the Vermont and New York shore lines accumulated the quartz derived from the disintegration of the gneisses into banks of purely silicious sands, frequently termed "primordial sea-beaches." The other materials, of finer texture, were washed out into the deeper waters, but reached sufficiently near the surface to allow of the existence of trilobites, annelids and sea-weeds. At length the silicious sediments ceased to accumulate, and limestones took their place, falling down upon the slaty foundations. In the Trenton age, the last of the limestones, this sea became disconnected with the Atlantic Ocean through the present Gulf St. Lawrence, as shown by the distinctively American types of life existing throughout the interior. The limestones were finally covered by the Utica and Loraine slates.

Partial elevations of the Champlain country had been in progress during the building up of the Cambrian and Cambro-Silurian, but there must have been a very important one after the deposition of the Loraine group. The whole Champlain Valley seems to have been then raised above water level, since no rocks of later age have been deposited in this basin within the limits of New England. The final results of all the elevatory movements have been the crowding towards each other of the primitive land-areas; the faulting of the primal slates; the raising of the beach beneath Burlington and St. Albans—and changing its color from gray to red—overturning many of the limestones and sandstones; developing the symmetrical folds in the red sandstone about Monkton and Ferrisburg, and the alteration of the calcareous beds into snow-white marbles.

THE GREEN MOUNTAIN ANTICLINAL.

The existence of the anticlinal ridge of the Green Mountains was the most important contribution to science made by the late geological survey of Vermont, though its value was not then appreciated. Nearly all our sections illustrate the existence of this structural feature. Only No. VI. is purely monoclinal, and this like VII. and VIII. is to be regarded as an inverted anticlinal. The elevatory pressure seems to have been greatest along the middle part of the State, so as to have overturned this main axis. In I. a mass of mica schist of undetermined age—possibly Montalban—constitutes the summit of the highest ridge, continuous from the Hoosac Mountain over the celebrated tunnel to No. II. in Searsburg, where it rests upon the eastern flank of the elevated country. The gneiss is narrowest at the tunnel and widest along section I., where it may readily be seen to be composed of three parallel axes. The more western one may not extend many miles northerly; and it is more like the typical Laurentian than any other area. Very satisfactory sections are obtained in the valleys of the Winooski, La Moille and Missisco rivers, cut down across this formation more than 3000 feet, just north of Camel's Hump, Mt. Mansfield and Jay Peak (compare IX. to XIII). Upon the high mountains the strata are apt to be obscured by extensive deposits of till. Logan's scheme of structure involved the existence of a synclinal instead of an anticlinal, while his description of Sutton Mountain* showed that the true structure could not be suppressed. Selwyn, his successor in office, declares that the physical character of the region entirely favors the anticlinal structure for the Green Mountains in Canada. Prof. J. D. Dana has also announced his conviction that these gneisses in southern Vermont are older than the quartzite and of Archæan age.†

In southern Vermont, where the elevated region is widest, the rocks are usually well-defined gneisses, including protogene. North of VI. the feldspar diminishes in amount, and at length is manifested in scattered crystals, seen chiefly where the layers are broken. An inexperienced observer will overlook the feldspar upon the higher mountains in the northern part of the State. It is properly a feldspathic mica schist. Adams, the first State geologist, suggested the name of "Green Mountain gneiss" for the whole terrane, in view of this marked lithological feature. We find, on examination, that this micaceous band is probably the equivalent of a mica schist or micaceous gneiss in several gneissic terranes of this age in the Connecticut hydrographic basins, in both States; and that it is overlaid by hornblende schist.

It follows from the relations of the Cambrian quartzites to the gneiss that the latter is of pre-Cambrian age. The "primordial sea-beach" defined the western limits of this ancient land. If we use a similar criterion for the determination of the eastern limits of the island, we must travel to Braintree in Massachusetts or far down in Maine to find them. There are unfossiliferous quartzites and limestones, probably the equivalent of these western bands, in Plymouth, Vt., Rhode Island, and near the mouth of Penobscot Bay. The first are about ten miles in length. There are also areas of slate of undetermined age. In later times the Connecticut Valley deepened sufficiently to allow of the growth of Niagara and Helderberg coral reefs.

* Geology of Canada, 1863, page 251. † Quar. Jour. Geol. Soc., XXXVIII., 397, 1882.

[*Feb.* 13*th*,

CORRELATION OF THE GREEN MOUNTAIN AND NEW HAMPSHIRE GNEISSES.

The sections will enable us to proceed a step further and correlate the gneisses just described with those of southeastern Vermont, the Connecticut Valley, and both flanks of the highlands between the Connecticut and Merrimack rivers in New Hampshire. First of all, upon Nos. II., III., IV. and V., the Green Mountain terrane repeats itself in the well-defined range marked on the Vermont map as extending from Halifax to Hartland. Next, passing the small Guilford, Brattleboro and Vernon areas, we find the terrane again rising with greater width from Winchester to Fitzwilliam in I., Swanzey in II., Surry, Gilsum and Stoddard in III., but largely covered by later rocks, Acworth and Lempster in IV., Croydon and Springfield in V., Hanover and Canaan in VI., Orford and Wentworth in VII., Haverhill and Benton in VIII., Bethlehem in IX., Jefferson and Berlin in X., and Milan in XI. This is the northern termination of the terrane. It next shows itself upon the Merrimack slope, viz.: at Peterborough in II., Deering, Weare and Dunbarton in III., Warner in IV., Andover in V., in very limited amount. It seems on this flank of the highlands to lie more in small patches than as a broad belt. The next appearance of this gneiss is in the remarkable range from Mason (I.), through Milford and Amherst (II.), Manchester, Candia in III., Northwood and Barrington in IV. This range is characterized by the thoroughly crystalline saccharoidal aspect of the constituents. No one familiar with typical Laurentian ground will find himself far from home between Mason and Deerfield, nor in Berlin and Milan at the northeastern extremity of the previously mentioned gneissic wave.

Upon V., VI., VII., is another conspicuous area, partly coincident with the hydrographic basin of Lake Winnipiseogee. This area, as colored upon the map, suggests a northwest rather than a northeast trend. Compass observations, however, show the northeast to be the common direction ; hence the whole of the original area is not visible, being concealed by later formations. This is the broadest of all of the terranes, and it comes up again in Maine, between Denmark and Bethel. Many would mistake the Winnipiseogee Lake exposures for granite, but the lines of foliation can almost always be discerned. The difficulty of distinguishing the two rocks is greater in the Maine than the Lake terrane. The descriptions given by Selwyn to the oldest Laurentian gneisses of Canada will apply well to those in the Lake district. The next fold is seen at Nashua and Hudson in I., Hampstead in II., and West Epping in III. There are still other areas of small size below section III.; especially in Massachusetts, where our published map shows the northeast terminus of the band which has afforded the *Eözöon* in Chelmsford.

Inasmuch as these several gneissic ranges resemble one another, and exhibit the usual phenomena of stratigraphical connection—whether by folding beneath superior formations or bending over still more ancient groups—it is but a necessary generalization to conclude that they came into existence in the same geological age, and that they are all to be ranked as the equivalents of the Green Mountain series, pre-Cambrian, Archæan or Eozoic. It may be remarked that the first has a northerly trend in southern Vermont, verging more easterly in the northern part of the State, and not extending into the Dominion of Canada more than twenty miles. The other ranges gradually course more easterly, and lie nearly in the normal northeast range of the corresponding terranes south of New England, or in the Highlands of New York, New Jersey, and the Blue Ridge of Virginia. We have, therefore, an extensive group of gneissic areas essentially continuous from Newfoundland to Alabama on the Atlantic border of this continent. They are of Eozoic age, coeval with the formations of the Laurentian highlands, and developed along a different line of growth. They constituted an Archæan Atlantis, now partially submerged, but playing an important part in the building up of the North American continent.

THE OLDEST OF THE GNEISSES.

The map, plate 18, shows the distribution of areas of gneiss, supposed to be the equivalent of the Green Mountain Gneiss, in eastern Vermont and New Hampshire, by the areas colored red.

These common gneisses overlie a peculiar rock, whose largest development follows the watershed between the Connecticut and

Merrimack systems of drainage—the tract of highest elevation in the State south of the White Mountains—and the group passes beneath the mountains north of the Merrimack basin. This rock is a gneiss, containing distinct crystals of orthoclase—from one-half to three inches in length—which are usually arranged in lines of supposed bedding. A more conspicuous ledge is rarely seen; and hence geologists have universally recognized and described the rock. It is the *Augen gneiss* of Europe, and Logan mentions it as a constituent of the Laurentian in Canada. It is not met with in Vermont.

Nearly thirty areas of this formation have been delineated on the New Hampshire map. The largest extends continuously from Jaffrey to Groton, dips beneath mica schists to rise again in Ellsworth, continues to Franconia, and then underlies the Bethlehem group of gneiss to arise for the last time to the surface at the Wing Road railroad junction. The extreme points thus indicated are 105 miles apart. On section I., this rock just rises to the surface in Rindge ; on II., the southern extremity of the main range is touched in Jaffrey ; on III., IV., V., VI. and VII., the rock is very conspicuous. Two ranges are seen in VI., VII. and VIII., and it unconformably underlies the other gneisses in several instances. The apparent doubling in VI. is occasioned by the crossing of a crooked range. Other rocks interstratified with and integral parts of the formation are ordinary gneisses, hard mica schists, ferruginous quartzites and fibrolite aggregates. The stratification is often obscure and entirely obliterated in many localities, or where the crystals of feldspar are irregularly disposed. No lower group than this has been recognized in any sections, or anywhere else in New England.

HORNBLENDE SCHIST GROUP.

Having ascertained the stratigraphical relations of the gneisses, we find the first rock covering them to be a band of hornblende schist, occasionally feldspathic, and not unfrequently 1500 feet thick. It is best understood in the southern parts of our field, partly because better exposed, and partly because it has been less studied in the north. First noticed in the Guilford and Brattleboro, Vt., anticlinals, I. and II., it was detected only by exploration to hold the same position on both flanks of the Halifax-

Hartland gneiss, II., III. and IV. On I. it also overlies the Green Mountain terrane. In New Hampshire it borders a tract of gneiss between II. and III. in Cheshire county; flanks the west border of the Hanover gneiss, and covers the Canaan synclinal in VI.; and overlies gneiss in Surry, III., and Haverhill, VIII. There is a continuous range of it close to the Connecticut River between Cornish and Haverhill. In fact, it is so constant next the older gneisses, that if it be clearly absent, the presence of a fault or of an unconformity may be assumed. In Vernon it encircles an area of gneiss, and the structure indicated is that of an overturned anticlinal. The rocks over the hornblende are the green schists formerly called talcose. This is proved upon I., III., IV., in Vermont, and the Connecticut River range about Cornish. Similar beds are associated with the green schists in Marlboro, II., and the Ammonoosuc gold field. It seems more intimately connected with the green schists than with the gneiss—though often only the hornblende band will be present.

HURONIAN.

This name is used as a matter of convenience to designate all the various schists of chloritic and argillitic aspect overlying the gneisses and inferior to the Cambrian, so far as known. The terranes in Vermont and western New Hampshire are the ones that have been studied the most, and are the most valuable for the determination of age, because more nearly related to the original Canadian exposures called by this name. The superiority of the main Huronian belt upon the east side of the Green Mountains to the gneiss is obvious upon every section from I. to VIII. This view is confirmed upon II. to V. by the inferior position of the Halifax-Hartland range of gneiss.

The Connecticut River range is first seen in IV.; and from thence to Maine and Canada upon every section, it adjoins the hornblende schist or older gneisses, resting upon them. From VI. to XI. it is easy to connect the Green Mountain and Connecticut River ranges by a synclinal fold. Upon XII. and XIII. the direct connection is interrupted by granites and schists that seem to occupy the place of the Halifax-Hartland range, II.–V. The apparently overlying position of the Huronian west of the calciferous in IX. and XIII. is due to inversion, as proved by the occurrence of the fossiliferous Helderberg in similar position just to the north of XIII. in Canada (Lake Memphremagog). West of the Green Mountains the Huronian has its normal development in Canada and in the northernmost counties of Vermont, gradually diminishing in breadth southerly. It is not found south of VII. In southern New Hampshire the argillitic, quartzose and micaceous divisions predominate nearly to the exclusion of the chloritic schists, which with the characteristic dolomite is seen in Raymond and Derry. Steatite occurs in it at Francestown in the ferruginous slates and in the mica schists of Derry. All the schists referred to this series invariably overlie the gneisses.

MONTALBAN.

So far the assignment of the formations to their proper order has been comparatively easy; but the introduction of the word *Montalban* immediately suggests discussion. Inasmuch as the typical locality, as shown by the name, lies within our territory, the relations of the group must be briefly discussed. The name of "White Mountain Series" was first employed by myself in 1869 as a matter of convenience, in the discrimination of the crystalline rocks of the White Mountain region and their extension into Massachusetts. Previously our geologists had usually regarded these crystalline schists as of Paleozoic age, probably Devonian. My studies in the Ammonoosuc district enabled me to advocate their pre-Silurian origin, and hence to give them a special name. It was not intended to describe them as a *system* separate from the Laurentian, though the conviction had been more than once stated in public that these rocks would probably prove to belong to a more recent series. This name was also applied with this original signification to the gneisses of central Massachusetts in Walling and Gray's Official Atlas in 1871.

A different use of the equivalent term *Montalban* was proposed by Dr. T. Sterry Hunt in 1871. It was applied to a somewhat similar series of schists overlying the Huronian, and expressly stated to include the rocks called Coös group and calciferous mica schists in our reports. In our belief, he has included under this designation rocks of different age, the one a system below, and the other above the Huronian. He has not yet given us any proofs of the later age of the Montalban derived from the study of the group in its typical locality along the presidential range of White Mountain summits; but the conclusions have been derived from general considerations concerning rocks developed in several states, provinces, territories and countries. There is a mica schist group later than the Huronian which will be noticed presently, but our observations, so far, have led us to believe that the feldspathic mica schist group of the White Mountains belongs to an older series, which might be called, as Professor Kerr has named it in North Carolina, the upper Laurentian. I have examined the gneiss of Lake Winnipiseogee in company with Dr. Hunt, who pronounced it Montalban. As this Lake gneiss has been shown above to be clearly older than the Huronian, and as it constitutes the axis of the Green Mountains—allowed by him to be thus ancient—it is obvious that the Montalban series, as defined by Hunt, embraces two groups of very different age. Hence the word has been used in two senses; but we invariably employ it in its original signification of pre-Huronian and post or upper Laurentian. The relative positions of the Montalban and Huronian have been sufficiently set forth in the New Hampshire reports.* They do not often come into juxtaposition. The examples cited in this report are from the northern part of the State.

MICA SCHISTS.

That there exists an enormous thickness of mica schist above all the rocks thus far described, especially in southern New Hampshire, is unquestionable. No author, who has devoted any attention to these groups, has suggested an inferior position for them. They may be called Silurian, Cambrian, or pre-Cambrian, according as each author is inclined to regard New England, very ancient, or on the verge of the Paleozoic. Such of the Rockingham group as is not referred to the Huronian belongs here, as shown in the Pack Monadnock Mountains (II.), Belmont, Gilmanton and Milton (V.) It constitutes the substance of several interesting mountains, like the Pack Monadnock, Temple and Lyndeborough west of the Merrimack, and Catamount, Fort, Not-

* Vol. II., p. 666.

tingham, Blue Hills, Blue Job, Hussey, Chesly and Teneriffe to the east. This orographic feature is paralleled in Mts. Monadnock, Kearsarge and Ragged of a possible older group carrying andalusite.

In the Connecticut Valley there are 10,000 or 12,000 feet of mica schists and associated rocks. Many of them are characterized by the presence of staurolite and garnet, and by this feature distinguished from a contiguous band of Cambrian clay slate. Its basal member is a quartzite, 1000 feet thick in Cheshire and Grafton counties, and frequently occurring in immense masses, as in Croydon, Grantham, Moose, Cuba and Piermont mountains. This rock resembles the Potsdam at the west base of the Green Mountains. In Washington county, Vermont, it may be replaced by a quartz schist often micaceous. The calcareous member occupies a great many square miles in Vermont, amounting to more than one-fourth of the entire area of that State. Logan regarded the Canadian extension of this band as of Niagara, or upper Silurian age. Dr. Hunt refers those rocks to the Montalban. Dana supposes the fossils at Bernardston, Mass., to be so connected with this terrane that they determine its age—being upper Silurian or Devonian. There are many difficulties involved in readily referring this entire series to the upper Silurian; but if any collector will bring in fossils from characteristic localities proving its Niagara age, there will be nothing in our interpretation of its stratigraphy inconsistent with such a discovery. The rocks are evidently the newest of any of the great systems of strata described in our reports. To elevate them to the upper Silurian would not carry any higher the chloritic, silicious or feldspathic schists already enumerated.

A brief discussion of the stratigraphy of the Coös and calciferous mica schist groups will show why they take their high place in our system, and illustrate the nature of the difficulties encountered in understanding the various dips and overturns of the strata in our field. These groups are not separated in our sections, as they are supposed to be essentially the same series, and their lithological differences such as result from local causes. The calcareous division lies chiefly in Vermont, and on XI., XII, XIII. west of a granitic area. The most eastern of the micaceous areas upon XIII., and a part of the same in V., are calcareous; all the other schists of this age in New Hampshire lack the limestone. There is no foundation for the statement sometimes made, that the staurolite and andalusite crystals have been produced by the proximity of granite or other igneous rocks at the time of their eruption. On the contrary, these igneous rocks are common in the calcareous areas where silicates are rare, and are absent where these cruciform minerals are abundant.

The natural relations of the micaceous group and the neighboring series are displayed upon VI., VII., VIII. Four series of rocks are disposed in a synclinal form: the micaceous group is at the summit, underlaid first by clay slate, second by the Huronian, and third by gneiss. The synclinal is complex, as is to be expected where elevating forces have been so active. Upon VI. there are nine, and upon VII. there are seven axes in the mica schist west of the Connecticut. So many groups in synclinal attitude must represent the natural order, and hence afford a basis for explaining apparent exceptions by overturns, faults and unconformities. Upon the other sections some one or more of these four groups are wanting, but those present invariably sustain the same relations to one another.

The calcareous division is widest where the natural relations of the four groups are manifested. To the south of VI. it has narrowed very much, and lies further east than the axis of the area northwards. This deflection has been occasioned by the elevation of the Halifax-Hartland range of gneiss, since it occupies the line of the central axis and has its northern end environed by the mica schists, as shown on V. Repetitions of this gneiss with the accompanying hornblende schist are seen upon I. and II., and there are others in Massachusetts. It would seem as if the clay slate and the Huronian were less constant than the mica schists and gneiss, since they do not appear along this range. The eastern band of the Huronian does not appear at all south of III., and its place over the gneiss may be taken by the hornblendic group. The absence of the clay slate alone is sufficient to enable us to assume the existence of an unconformity of the mica schist over the hornblende group. If the slates and Huronian were ever deposited over the Halifax-Hartland gneiss they have been subsequently removed by elevation and denudation before the deposition of the mica schists.

An examination of the more northern sections shows that older or eruptive rocks take the place of the Halifax-Hartland gneiss on IX., XII. and XIII. Upon IX. the granite has uplifted the adjoining strata so that if our order of the groups were determined by their succession on this line, we would call the micaceous rocks older than the slates, and the Huronian newer than the slates. The intrusion of this immense mass of granite gave an unusual dip to the mica schists, and being of unyielding character after consolidation, it has caused the more flexible slates and chloritic schists to be overturned upon both sides. The fundamental gneisses upon both sides seem to have been unaffected, except that they stand more nearly erect than before. Upon XII. and XIII. the granite is larger in amount, and accompanied by gneiss and Huronian—though scarcely shown upon the profiles—and the overturns are less conspicuous. Just to the north of XIII. the overturning of the Huronian is made more obvious by the presence of Helderberg fossils in strata dipping beneath it. The eruptive granites have penetrated fissures in the mica schists, so that the latter must be the oldest. Logan and the Vermont report regarded the granites as of Devonian age, because the disturbed rocks were thought to be upper Silurian.

It seems likely that these granites upon IX., XII., XIII., were connected with the uprising of the Halifax-Hartland gneiss in southern Vermont. If granite is derived from the fusion of schists, these bosses might have originated from the melting of rocks connected with that range deep down in the earth. Small areas of gneiss are connected with these granites upon the same axial line in the middle of the calciferous groups, and Selwyn finds them near the United States border in Canada; saying these "are apparently repetitions of the crystalline schists of the great Sutton mountain anticlinal to the northwest."* Granite also occurs there. The end of the gneiss range is connected with the granites upon IX., XII. and XIII. by an anticlinal line, seen upon every intermediate section. Upon VIII., X. and XI. this line is developed into a mountainous range, and the strata

* Geology of Canada; report of progress for 1879-80, page 5.

have very low dips. Thus the normal structure of this great basin is that of a synclinal with an anticlinal in the middle more highly elevated than the sides, and sometimes bringing up the underlying gneiss. This feature is not confined to the calciferous group. Dozens of similar folds can readily be seen upon our chart; and the discovery of this type of structure aids materially in the understanding of the New England folds. Authors have pointed out a similar type of basin in the Appalachian region of Pennsylvania and Virginia, as instanced in Taylor's section across the coal measures near Nesquehoning, Pa.

There is no great significance to be attached to the subordinate foldings of the calciferous group apart from this central line. In the middle of the area upon I. the underlying hornblende rock is brought up twice, and there are as many as five folds. Upon III. the strata are entirely monoclinal, and separated by a band of clay slate and a fault from the non-calcareous division. Along White River, upon VII., but not delineated in our figure, we have discovered a horizontal fault in this group, and there must have been an extensive shoving westward of part of the series. The effects of the dislocation have not been observed outside of the formation, nor for a distance of more than 500 feet.

MT. ASCUTNEY GRANITE.

Upon V. we have delineated two peaks of granite or syenite known as Mt. Ascutney and Little Ascutney. The igneous rock seems to have been erupted from below through one or more vents and spread over the rock adjacent, very much in the manner of modern lava. The importance of these facts leads us to give them more in detail than usual. All the varieties of rocks occurring upon the mountains are well represented in the Museum.

The summit of Ascutney lies near the southeast corner of Windsor; but portions of the mass are situated in the towns of West Windsor and Weathersfield. If the two mountains were just alike, the granitic area, when protracted upon a map, would resemble a pair of spectacles; as it is, the eastern higher area is four and one-half miles long, two and one-eighth wide, and the summit 3186 feet above sea level, while the base of the cone is 1200 feet above the sea. The western area is nearly circular, one and one-fourth miles in diameter, and the apex 1700 feet above the sea. The rock is often a hornblende granite—mica not being excluded—and the variety called *granitell* by Dr. Hawes, containing neither of the accessory minerals, is abundant in irregular patches in every part of the cones. Brecciated masses composed of the underlying stratified rocks are plentiful upon the west side of the larger mass and upon the smaller mountain; insomuch that one can easily believe portions of the granite have been made from the melting down of the fragments. The major axis of the "spectacles" is six and one-half miles long, at right angles to the course of the strata. Two stratified groups underlie the unstratified area. Most of the eastern cone is located upon the calciferous mica schist. The rest of it, and the smaller cone, lies upon gneiss. The gneiss underlies the mica schists at the same angle of dip, and we do not yet discover any stratigraphical axes in the latter. The relations of all these rocks appear upon section V. This granite seems to occupy a position similar to that of the gneissic anticlinals in Guilford, I., and Brattleboro, II., and is like Black Mountain in Dummerston.

There is no evidence of elevation of the schists in consequence of a disturbance, when the igneous mass came up. The same local variations appear upon the south that are visible upon the north side of the mountains. The mica schists manifest the presence of heat for a distance of 500 feet or more from the granite. The slates have been indurated so that they ring like iron when struck by a hammer. The limestones are sometimes calcined, and even glazed. Veins enter both the rocks from the granite for several yards distance. The gneiss is not altered at the contact line. It would seem, therefore, as if we had here examples of contact-phenomena, and only the later strata are affected, because the gneiss had been already made crystalline before the eruption of the granite.

The adjacent hill-tops of the mica schist country are approximately 1200 feet above the sea, which corresponds with the elevation of the base of the granite. On entering the valleys of erosion at the base of the granite, where small streams have removed considerable rock, it is discovered that the schists run under the igneous rock, certainly for 300 feet. Were a tunnel driven through the mountain, as through the celebrated Kammerburg of Bohemia, similar phenomena would be found; below a certain horizon—say 1200 feet—only the schists would be cut through, excepting the central plug of granite. This cone of granite has its base upon the floor of schists, while its height is about 2000 feet. It is to be regarded as an overflow of igneous matter upon the common rock of the neighborhood, and where it comes in contact with clayey layers they were baked; and where limestones were heated, the result was calcination, induration and glazing. Upon this view it is easy to understand why there should be an indurated belt about 500 feet in width enveloping the cone. The heated mass covered the surrounding country just so far, and that outer shell has since been removed by denudation.

My father, in the Geological report of Vermont, advocated the doctrine of the derivation of the granite from below; but supposed the cone continued to enlarge below the surface, and as he conceived of it as a liquid, suggested its enclosure by walls of schist, which have subsequently been removed by erosion. The prevailing modern view of the origin of granite is like this, except that it demands a greater degree of erosion. Says Prof. J. W. Judd in his work on volcanoes, 1881, p. 252, "The plutonic rocks, as we have already seen, exhibit sufficient proofs in their highly crystalline character, and in their cavities containing water, liquified carbonic acid, and other volatile substances, that they must have been formed by the very slow consolidation of igneous materials under enormous pressure. Great pressures, it is evident, could only exist at great depths beneath the earth's surface. Mr. Sorby and others have endeavored to calculate what was the actual thickness of rock under which certain granites must have been formed, by measuring the amount of contraction in the liquids which have been imprisoned in the crystals of these rocks. The conclusions arrived at are of a sufficiently startling character. It is inferred that the granites which have been thus examined must have consolidated at depths varying from 30,000 to 80,000 feet beneath the earth's surface," etc.

If Ascutney were the only granite mountain in New England, it might be easy to imagine an erosion of from 20,000 to 70,000 feet from around it; but what is true of this mountain must have been true of all New England and of the whole crystalline area of the Atlantic coast. A tract of country, say 1000 miles long and 300 miles wide, according to this view, has been covered by rock from four to fourteen miles in thickness, which has been eroded and transported by streams of water oceanward. If that were true, then our Atlantic coast line would have been several hundred miles nearer the old world than it is now.

Such extreme views are entirely unnecessary. Two other agencies may be called upon to explain the existence of compression—lateral pressure and the weight of the column of lava. Or, if it be necessary to believe that the liquids condensed so far below the surface, the igneous mass may have flowed upward through fissures without losing its inclusions, and kept them intact till within a few hundred feet of the light. If slides under the microscopes can hold drops of liquid carbonic acid restrained by the twentieth part of an inch of rock-wall, why could not several hundred feet of pasty cooling lava be equally effectual? At the surface the inclusions must have escaped into the atmosphere just as upon streams of modern lava, steam and vapors boil and disappear. After solidification, all these imprisoned vapors are firmly enclosed whether within ten feet or ten miles of rock. The original surface, now denuded, may have been a genuine lava. Some modern lavas, like granites, contain inclusions of condensed gases, and present many of the phenomena characteristic of the older rock; yet no one supposes that five or ten miles of rock have been removed from above them. The conditions of modern aqueo-igneous lava fusion are not very different from those invoked for the origin of granite.

It is easy to name other mountains of granite and porphyry, which so resemble Ascutney as to make one believe they will present evidences of a similar origin. Such may be found upon our sections—as Moose Mountain near the east end of V.; Green Mountain, Effingham, and the Ossipee Mountains in VI.; Pequawket in VIII.; and Starr King, near Jefferson, in IX. There are many others in the White Mountains.

Another class of volcanic ejections, probably older than the granites of the White Mountains, are largely developed upon sections XI. to XIII. in Vermont. The rocks are referred to the Huronian in our descriptions, and consist of stratified diabases, protogenes, epidotic and chloritic schists, fine-grained quartzites, etc. It is supposed they may have been metamorphosed from volcanic ashes and scoriae. Some of the mountains exhibit dome-shaped features, and therefore resemble volcanic piles much degraded. Selwyn calls the extension of these rocks into Canada the "Volcanic group," and was the first person to call attention to their resemblance to rocks of igneous origin in Great Britain and Australia. These views will commend themselves to those who are familiar with the lithological character of igneous rocks.

COLONIES.

M. Jules Marcou has published in the *Bulletin de la Société Géologique de France*, 1880, a paper upon the Colonies in the Taconic rocks upon the borders of Lake Champlain. He thinks that the Taconic (Cambrian) rocks in the northwest part of Vermont contain lenticular masses of limestone, characterized by the presence of more recent fossils than those imbedded in the slates. Potsdam slates, for example, carry beds of limestone in which Chazy fossils are imbedded. It is supposed that these animals were prophetic types of those that were to be introduced more abundantly in the later periods. He subdivides these "Taconic slates" into the Swanton group, 800 metres thick; the Phillipsburg group, 1000 metres; and the Georgia schists, with *Olenellus*, 130 metres; total 1430 metres or 6465 feet. In the Vermont report all these beds are included in the Georgia group. Of these groups, the Swanton slates contain graptolites similar to those at Point Levis, near Quebec, and he believes that the Trenton limestones of Highgate Springs exist as lenticular masses imbedded in the graptolitic slates. The Phillipsburg group contain the lenticular beds called locally "dove-colored marble." Fossils of Chazy age have been obtained from them and described by Billings. The Georgia slates contain *Olenellus*, without any colonial concomitants. Below these several groups, Marcou locates the St. Albans slates, 1000 metres thick, and containing colonies of *Bathyurus* and an *Orthoceras*.

My own observations, made before the visits of Prof. Marcou to Highgate Springs, represent the Trenton as resting unconformably upon the Swanton slates rather than imbedded in them. Sir W. E. Logan published sections of the Highgate and Swanton rocks in the Geology of Canada at variance with the idea of colonies. Logan's view, as presented in an ideal section of the rocks near Montmorency, seems to afford the proper explanation of the present condition of the strata along the Champlain Valley west of the middle Potsdam range. He supposes an overturn of the east side of the synclinal of Cambro-Silurian, and a shoving westward of Potsdam rocks, so as to overlie them, sometimes in one way and sometimes in another. By such a motion the Potsdam may be made to overlie unconformably any of the Cambro-Silurian series, and even itself. At Lone Rock point in Burlington, section X., our catalogue represents the Winooski (Potsdam) dolomite as overlying this dove-colored Chazy limestone, which in its turn is above the black slate. The limestone is cuneiform in aspect, and we regard it as naturally folded beneath the Potsdam. The slates have been regarded by Emmons as older than the Potsdam because of their inferior position. It is so represented upon our sections VII., VIII., IX. This same slate skirts the west side of the middle Potsdam range all through the Champlain Valley. A partial sketch of the relations of these slates and Cambro-Silurian groups, at Snake Mountain (VII.), is given by Professor Dana from the notes of Rev. A. Wing.* It represents the Potsdam as crossing transversely the Chazy limestone, Trenton limestone and Loraine slates upon the steeply inclined part of the synclinal. The slates have been completely doubled upon themselves, so as to lie nearly horizontally beneath the red Potsdam sandstones. The explanation of this structure supposes first a fold of all the beds from the Potsdam to the Loraine. This becomes steeper and steeper and finally breaks. The rupture allows the Potsdam to remain with a small dip, while the limestones stand nearly vertical. As the pressure continues, pushing westwardly, the red sandstones are shoved towards Lake Champlain, so as to cover all the Cambro-Silurian groups. A slight irregularity in the motion, combined with denudation, has caused an angle of the sandstone to jut over the limestones, and reveal

* Amer. Jour. Sci., III., Vol. XIII., p. 413.

them in their natural succession upon both sides of the flat-topped Snake Mountain.

The Vermont report identified these black slates of Snake Mountain with the Utica or Hudson River beds. They seem to lie altogether upon the west side of the red sandrock range, while the Georgia group is commonly upon the east. These two slates may both be present, the former being often calcareous and full of white calcite veins, the latter being usually silicious. The veins appear only in the neighborhood of the fractures.

After reviewing the question of the "colonies," the presence of the cuneiform segments of Chazy limestone—whether injected into the slates or folded beneath the Potsdam—and the marked lithological differences in the slates, I am at present inclined to believe that future investigations will confirm the reality of Logan's theory—that the folding of the limestones and slates, combined with a subsequent shoving of the sandstones over them, will correctly explain the present position of the several groups upon the east side of Lake Champlain.

THICKNESS OF THE FORMATIONS.

For a thousand further details the reader is referred to the published and manuscript sections and catalogue, accessible to all inquirers at the Museum. I will close by adding a list of the several formations of New Hampshire and Vermont in their supposed natural order, with their estimated thicknesses.

	FEET.
Devonian Helderberg, near Memphremagog Lake,	200
Niagara group, at Littleton, etc.	500

CHAMPLAIN VALLEY.

Loraine slate,	400
Hydro-mica schist (Taconic range),	2,000
Trenton limestone,	400 to [illegible]
Black River and Birdseye limestone,	40
Chazy limestone,	400
Levis limestone,	600
Carried forward,	4,740

[*Feb. 13th,*

Brought forward, . .		4,740
Upper calciferous sandrock, ...		200
Lower " "		400
Fucoidal layer, ...		200
Potsdam sandstone, red, ...	500	
" " gray, ...	310	
" " quartzite, ...	1,200	1,200
Georgia slates, ...		3,000
Cambrian slates and schists, ...		4,000
Total of Champlain Valley, ...		13,740

Crystalline Groups.

Calciferous mica schist and Coös group, . .	12,000
Kearsarge group, ...	1,300
Rockingham mica schist, ...	6,000
Merrimack group, ...	4,300
Huronian, ...	12,000
Hornblende schist, ...	1,500
Montalban, ...	10,000
Lake Winnipiseogee (Green Mountain) gneiss, . .	18,600
Bethlehem gneiss, ... : . . .	6,300
Porphyritic gneiss, ...	5,000
Total crystalline,.	77,000
Grand total, ...	90,740

Note.—*In the American Museum of Natural History, the series of rock specimens illustrating the above described sections are placed on exhibition, together with colored diagrams of the sections numbered correspond.*

ARTICLE IX.—*On a Fossil Scorpion from the Silurian rocks of America.* By R. P. WHITFIELD.

The discovery of the fossil remains of scorpions in the Silurian rocks of Sweden, was first made known to the Swedish Academy of Sciences on November 12th, 1884, and attracted much interest in as much as it apparently carried the history of air-breathing or land animals much further back in geological time than had hitherto been known. This discovery was no sooner made known than it was learned that a similar one had been made in Scotland. The first published statement of the Swedish find was made in the *Comptes rendus* of the French Academy, on December 1st, 1884, and that of the Scottish one in the *Glasgow Herald*, December 19th, 1884. The deep interest felt in these discoveries caused them to be published in many scientific and other journals, by which means they soon became widely known. On June 8th, of the present year, Mr. A. O. Osborne, of Waterville, N. Y., wrote me, and sent some "fossils of special interest from the Waterlime beds" near that place, on opening which I found among them a very nicely preserved scorpion of small size. The almost simultaneous discovery of rare and peculiar fossils at widely distant localities has often been remarked, and in this instance is quite peculiar on account of the small size of the objects. The dates of the discovery of the several scorpions are, for the Swedish specimen, although the first made known, June, 1884; that of the Scottish specimen, June, 1883, one year earlier; and that of the American specimen, November 16th, 1882, as shown by Mr. Osborne's diary. The value of it had not been recognized, however, until Mrs. Osborne saw the notice of the others in print.

CONDITION OF THE SPECIMEN.

The specimen is imbedded on the rock with the dorsal surface exposed, and is greatly compressed, as are all the fossils found in the same beds. Its thickness dorso-ventrally, is less than a twentieth of an inch; the crust being extremely thin and the foreign material between the dorsal and ventral plates almost inappreciable. The dorsal crust is preserved over about two-thirds of the surface, including all of the cephalothorax and more than half of the

[*Oct.* 10*th*, 1885.]

preabdomen and a portion of each of the limbs and appendages of one side ; while over the rest of the preabdomen and what remains of the postabdomen or tail, parts of the first five segments, the inside of the ventral crust is exposed. The posterior three-fourths of the fifth tail segment and the sixth or sting is missing. The absence of this latter portion is much to be regretted, a fact which I realized on first examining it, and more fully on further study. The fragment of stone on which the specimen lies has been chipped from a large block and this important part left behind. Search has been made for it, and also for fragments of other individuals, but without success.

GEOLOGICAL POSITION.

The *geological horizon* of the American scorpion is perhaps not very different from that of either of the other Silurian species. The bed in which it was found, the Waterlime rock, is at the extreme lower limit of the Lower Helderberg group, or below it. Prof. James Hall, in 1875,[1] appeared to consider it as a separate formation, lying between the Lower Helderberg and Niagara groups.[2] This would place it near the middle of the Upper Silurian. Profs. Thorell and Lindström state on pp. 4 and 5 of their Memoir,[3] that the Swedish specimen was found at about the middle of the beds considered as the equivalents of the Upper Ludlow rocks of England, or the Lower Helderberg group of New York, and the Scottish specimen was derived from the uppermost limits of the Upper Ludlow beds.[4] It is probably impossible to draw a line of strict parallelism between the different parts of the European Upper Silurian rocks and those of New York, as the representative fossils occur at relatively different parts of the formation in the different countries. But it would appear that the American form came from a somewhat lower horizon than either of the others. In each case they are associated with similar forms of fossil remains, as Eurypterus, Pterygotus, Ceratiocaris, and Leper-

[1] 27th Rept. State Cab. N. Y., pp. 127, 128.

[2] At several localities south of Schoharie, as at Kingston, N. Y., it is difficult if not impossible to draw a line between the Waterlime beds and the Tenaculite limestone, which is considered as a part of the Lower Helderberg group proper, the beds gradually passing into each other.

[3] On a Silurian scorpion from Gothland, by T. Thorell and G. Lindström, Kongl. Svenska Vetenskaps-Akad. Handl. Bandet 21, No. 9.

[4] On p. 16 of Thorell and Lindström's Memoir they state that their specimen comes from thin marly clay, probably belonging to the base of the Upper Ludlow series.

ditia ; and these are restricted within a limited vertical range at each locality, but do not hold the same relative position in the formation. I am also inclined to consider the American form as more embryonic in its structure, or further removed from the living scorpions in some of its features as will be seen from the description.

ZOÖLOGICAL RELATIONS OF THE SPECIES.

On first studying the specimen, it appeared to me desirable to include it under the same genus with the other Silurian scorpions if possible, although recognizing the differences between them, as shown by the statements of characters given in *Nature*, *Science*, and other publications ; especially in the existence of double terminal claws on the walking limbs of the American specimen. At the time of writing the brief notice given in *Science* of July 31st, 1885, I had not seen the scheme of classification adopted by Profs. Thorell and Lindström ; but, when through the kindness of Mr. S. H. Scudder and afterward from a copy sent me by Prof. L., I was enabled to see this, I recognized at once the impracticability of including it under their genus *Palæophonus*. I therefore propose for it a new one under the name *Proscorpius*, with the following characters.

PROSCORPIUS, new genus.

Cephalothorax with large dorsal eye lobe, the eyes small, one on each side of the median line. Lateral eyes on ridges as in the living scorpions. Sixth ventral segment of the preabdomen, counting from behind, large, equal in length and breadth to the corresponding dorsal segment in the only species known. Anterior walking limb terminating in a bifid claw. Postabdomen not reversed as are those of the living scorpions. Type *P. Osborni.*

In S. H. Scudder's new classification of the Palæozoic scorpions, now printing for Vol. 2 of *Zittel's Manual of Palæontology*, he divides the Eoscorpioidæ into three sub-families, Proscorpionini, Eoscorpionini and Cyclopthalmini, the former embracing the following characters: "Dorsal eye tubercle of moderate size, situated mesially on the front margin of the cephalothorax, the eyes small. Lateral eyes in two rows on the antero-lateral border."

By this arrangement the present form is classed with the Carboniferous Eoscorpions, rather than with the Silurian Palæophonus, on account of the bifid claws terminating the walking limbs. This species will therefore be arranged in the following manner:

Order SCORPIONIDEA, Sund.

Sub-order ANTHRACOSCORPII, T. & L.

Family EOSCORPIOIDÆ, Scudder.

Sub-family PROSCORPIONINI, Scudder.

Genus PROSCORPIUS, Whitf.

DESCRIPTION OF THE SPECIES.

Proscorpius Osborni,

PLATES 19 AND 20.

Palæophonus Osborni, Whitf.; *Science*, *Vol.* 6, *p.* 88, 1885.

Specimen with the dorsal surface exposed. Cephalothorax and preabdomen united measuring nearly nine-tenths of an inch in length, and the first four segments of the postabdomen, very slightly displaced and thereby shortened, are just half an inch in length; the fifth segment is imperfect, the sixth entirely absent. Surface smooth, without granules. Specimen probably a female.

Cephalothorax quadrangular, narrower than the first segment of the preabdomen, length and width equal, somewhat trilobed on the anterior margin from the projection of the eye tubercle on the anterior border. Eye tubercle subquadrate, one-third as wide as the head, slightly elevated and bearing a single eye on each side of the median line; eye spots small. Lateral eye lobes rounded on the margin and slightly extending beyond the line of the head behind; eyes on ridges near the antero-lateral borders. Posterior border of the cephalothorax forming a broad band, resembling a segment of the preabdomen but proportionally narrower.

Preabdomen elongate-elliptical in outline, gradually widening posteriorly to the fifth segment, and more rapidly narrowing backward from that point; the posterior plate being paraboloid in form and only half as wide on the posterior as on the anterior border. The other plates somewhat gradually increase in length antero-posteriorly, from the first or anterior one, to the last. On each of the dorsal plates there occurs a sharply elevated line or ridge, a little behind the anterior border and parallel to it, and is continued across the lateral ends to near the posterior margin ; just as in many of the modern scorpions. No other ornamentation occurs on them, but a few wrinkles, probably from compression of the crust, are seen on the two posterior plates. The right-hand end and surface of the ventral plates of the preabdomen are shown over more than one-third of the area, exposing their inner surface. This is entirely smooth, but for a slight wrinkling here and there, and the evidence of a thickening near the lateral margin on the three last. There are six ventral plates showing, which appear to have been of rather larger size than the corresponding dorsals, the anterior one of the six being apparently both wider and longer than the second or corresponding dorsal. None of these plates show satisfactory evidence of stigmatic slits ; the last but one, or the hindermost of the four stigmatic plates, as seen in the modern scorpions, bears a slight mark in the position occupied by the slit when present, but which is altogether too indistinct to afford satisfactory foundation for asserting the presence of stigma in this example. The evidence for the existence of these organs is more negative than positive. Along the left side of each of the four stigmatic segments in the position occupied by the chitinous integument which unites the dorsal and ventral plates in living scorpions, there occurs a depressed area, deepest near the anterior part of each segment, which in certain lights look as if they had been perforated. The nature of these depressions is not yet understood.

The *postabdomen* shows only the inside of the ventral or lower plates of the four anterior segments, and a little of the upper end of the fifth. The first is very slightly displaced in relation to the last segment of the preabdomen, and the second from that of the first, but not enough to materially change the form or direction of the whole. Each of the segments show two ridges (depressions on the specimen) converging toward the posterior end of the segment and widening out anteriorly, and also the sinuosities on the anterior end of each, filled by the chitinous membrane to accommodate the bending of the joints one upon the other; indicating that the bending of the tail would be downward and not upward over the back, as in the more recent and living scorpions.[5]

Of the appendages of the cephalothorax there are preserved parts of each of those of the left side, and a fragment of the mandible and of three, or perhaps four of the limbs of the right side. The following description of these appendages is taken from the left side entirely.

The *mandible* is proportionally large, and with the claw is ovate in form in its flattened condition. A slight mutilation across the middle of its length obscures the actual outline of the movable finger, but it is prolonged and pointed at the tip, while no actual dentition of the edge of either portion can be definitely asserted. From the flattened condition of this appendage it presents a somewhat different appearance under different lights, when examined under a high magnifying power. The figure 2 *a*, plate XX, represents its appearance with the light in one direction; figure 2 *b* represents it as seen with the light directed in the opposite line, when the tip of the fixed portion can be seen overlapping the other very slightly. In still another light, directed almost lengthwise of the mandible, the sutures and lines of junction are lost, or nearly so, while on the margin there appear lines, as if it were margined with hairs, as in figure 2 *c*. This may possibly be only an accidental character dependent on the fracture of the rock.

The *palpus*, which is nearly entire, being only broken through in one spot, is of moderate length but quite strong. The scapula is large and longer than wide and curved on the anterior edge; the humerus is nearly three times as long as wide; brachium short quadrate; hand moderate in size, bulbous near the base with a proportionately long immovable finger, slender, curved and smooth on the edge, movable finger slender and curved like the other.

The *walking limbs* differ from each other in size and proportions. The first is short and slender, the joints of nearly equal length; the last one proportionally the longest and terminated by

[5] On examining this portion of some embryo scorpions which I took from the body of a female preserved in alcohol, I find the tail bent symmetrically under the body with the extremity placed among the walking limbs, and the concave surface of the joints placed against the body, not indicating in any way the reversed position assumed in the living stages. These embryos were too small to show the sting or to reveal its position or direction.

a double claw, very similar to the living forms.[6] Of the second walking limb only parts of two joints are exposed by the breaking out of the surface above them. Of the third, the first joint seen (coxa?) is very short and close to the abdomen, the second is nearly twice and a half as long as wide, and the third has also been long. Of the posterior walking limb a very short first joint (coxa?) is visible, like that of the third limb, and a part only of the second.

Geological formation and locality.—The specimen is from the Waterlime beds at Waterville, N. Y., and was obtained November 10th, 1882, by A. O. Osborne, and has now become the property of the Museum.

GENERAL OBSERVATIONS AND COMPARISONS.

The general form and appearance of this American scorpion is more like that of the Scottish than of the Swedish Silurian scorpion, and resembles very much in general aspect many of the living forms, but differs in several particulars from all of them. One of these differences, readily observed, is the short cephalothorax, and the crowding forward of the limbs and appendages. In the Swedish fossil the posterior limbs are placed opposite the second abdominal segment, while here they are immediately opposite the first segment. Another and very important difference between this and all other forms, consists in the existence of six large ventral plates to the preabdomen. In all the living species which I have examined, and in the fossil forms so far as I can ascertain, particularly the Scottish Silurian form, the fifth preabdominal ventral plate, counting from behind forward, is rounded on the anterior margin and narrow, as in the living forms; while the sixth, to which the pectinated combs are articulated, is reduced to a very small size. On the contrary, in this specimen the sixth is fully as wide laterally, and as long in an antero-posterior direction as the corresponding, or second dorsal plate, as counted from the anterior end. This feature, if properly understood, is a very

[6] Mr. S. H. Scudder, who has examined the specimen, differs somewhat from myself in regard to the details of this limb. The visible joints he reduces to three or four, and thinks there is a small spine at the outer end of the penultimate joint. On careful re-examination I cannot reduce the number of the joints except by calling that nearest the body a fracture, which I think doubtful, and I am entirely unable to find the spine. An outline drawn by Mr. Scudder to illustrate his idea is given on plate XX, figure 4.

important one and must require a great modification in the form and position of the organs corresponding to the pectinated combs of the other scorpions.[7] What these modifications are is not known, as they are not seen, and only the end of the ventral plate for a length of rather less than a twelfth of an inch is visible on the specimen. A third important difference, at least between this

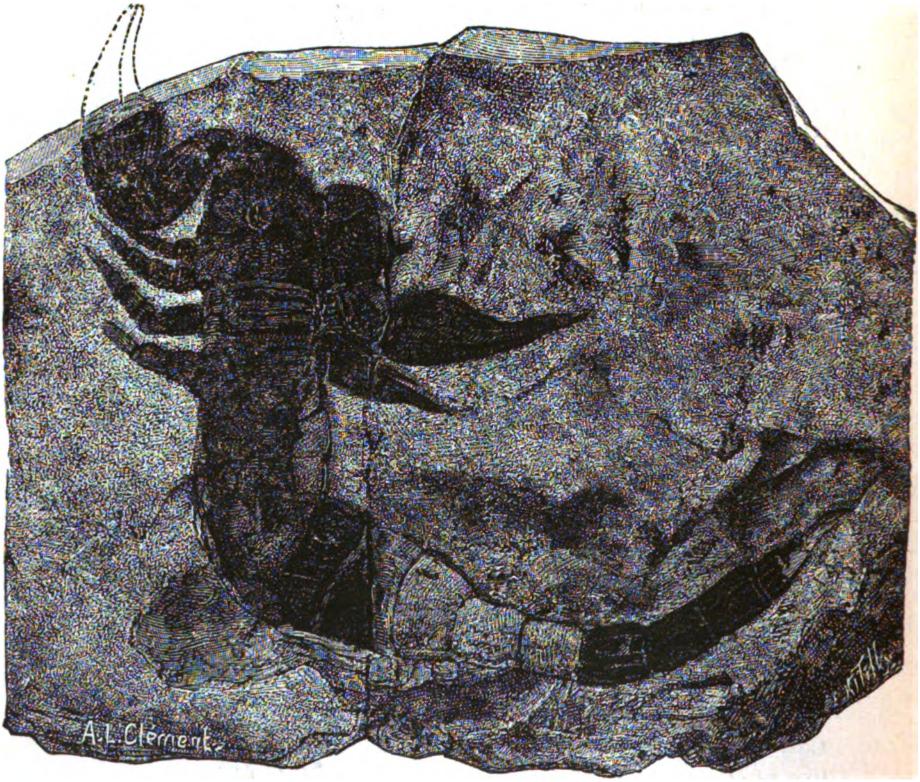

FIG. 1.—Fossil scorpion from the Silurian rocks of Gothland, Sweden, enlarged. (From *Nature.*)

and the living forms consists in the position of the tail or post-abdomen in its relations to the other part of the body. In the living forms this appendage is reversed in its mode of articulation,

[7] In the embryo specimens mentioned in a foot note on a previous page, the small plate between the pectinated combs appears to be as small proportionally, or nearly so, as in the adults; and I can find only the five ventral plates occupying the preabdomen behind it.

and is carried arched over the back of the animal; consequently the sinuate side of the joints are above when the tail is straightened out from the body, and the straight line of the articulations is below. In this specimen it appears to have been directly the opposite, and from Thorell and Lindström's figure I judge the Swedish specimen was the same; and I presume the reversed position of the tail was assumed by its descendants at a later period.

WAS IT AN AIR BREATHER?

Concerning the terrestrial habits of these Silurian scorpions, the present specimen affords but little evidence, and what is afforded is rather of a negative character. Although there can be no doubt of its near zoölogical affinities with the true scorpions, I can find no sufficient reason for supposing it to have been an air-breather other than its general analogy with those which we know to be such. The absence of anything that can with probability be said to resemble a spiracle in any of the four ventral plates, and in the position where they should appear, is certainly not favorable to that theory. There is every reason to suppose, from geological shore-line phenomena, that land existed in the near vicinity of the locality where the fossil was found; at least in the Medina and Clinton epochs, and we can readily believe the Waterlime beds themselves to have been deposits from shallow waters; so there may have been opportunities for a land animal to be drifted out to sea. But the existence

FIG. 2.—Fossil scorpion from the Upper Silurian rocks of Lesmahagow, Lanarkshire, Scotland, found by Dr. Hunter, Carluke; magnified two diameters. (From *Nature*.)

of land near by cannot be taken as a proof of the air-breathing nature of an animal unless that animal affords some structural evidence of the fact. What the peculiar stigma-like spots occurring in the chitinous integument of the left side of the specimen may have been I am unable to say; possibly only a form of ornamentation; their position is altogether too anomalous, so far as I know, among animals of this group, to warrant the expression of an opinion as to their use. I am much more inclined to think, therefore, that the specimen was aquatic in its habits than otherwise, and that the terrestrial habits and air-breathing nature of the group was a feature developed in subsequent generations; and that we have here a link between the true aquatic forms like Eurypterus and Pterygotus, and the true air-breathing scorpions of subsequent periods.

ARTICLE X.—*Notice of a new Cephalopod from the Niagara rocks of Indiana.* By R. P. WHITFIELD.

Family NAUTILIDÆ.

Genus LITUITES, *Montfort.*

Lituites Bickmoreanus, n. sp.

PLATE 21, FIG. 1–3.

Shell large and robust, composed of but few volutions, probably not more than three; but which increase very rapidly in size, are loosely coiled at first, but afterwards come in contact, but are not to any extent embracing; are obscurely subquadrate in a transverse section, flattened on the dorsum and very strongly ribbed on the sides and across the ventral surface, with heavy, rounded, oblique, transverse ribs or undulations. The ribs are separated by broad concave interspaces, and are arched strongly forward in crossing the shell from the dorsal to the inner margins, are united across the ventral surface in a rounded arch, but are obscure or nearly obsolete on the back. The outer section of the shell in the adult stage of growth is deflected in a nearly straight line to a distance nearly equal to the diameter of the outer coiled portion. On the straight part, near the aperture, the undulations of the surface are subdued and finally become obsolete, the shell being marked only by smaller undulations of growth parallel to the margin of the aperture. The aperture in the adult shell is not contracted laterally, but is characterized by a broad deep sinus on the back, nearly equal in width to the flattening of the dorsum, and extending to a distance more than equal to one-half the width of the volution at the same place. On the ventro-lateral angles there occurs other deep rounded sinuses, forming a broad lobe-like extension on the sides of the shell and a ventral lip of considerable extent, the true form and dimensions of which cannot be determined from the specimen.

The surface of the shell is covered by fine, almost microscopic lines which run lengthwise of the coils, and also by finer transverse lines of which three occupy the space of one of the longitudinal lines, giving a very fine and beautiful surface structure.

The septa are moderately concave, and their edges are seen arching backwards on the dorsum where they are truncated by the flattening of the back. They are arranged at distances from each other rather less than that between the transverse undulations of the sides, so that ten of them occupy a distance equal to eight of the undulations. The siphon is rather small for the size of the shell and occupies a position nearly central.

This may justly be considered one of the most remarkable of the American fossil cephalopods. Its very robust character would lead one to doubt its generic identity with the true *Lituites*, and especially so when the strong undulations of the surface are taken into consideration. The small number of volutions is also a peculiar feature. The inner ones of the specimen figured have been to a great extent filled with crystals of lime-carbonate, but are greatly compressed vertically. But there cannot have been more than two or two and a half volutions, and the outer one on the deflected portion has attained a dorso-ventral diameter of over two and a quarter inches. A second imperfect specimen shows the inner volutions very laxly coiled, and not coming in contact with each other until the outer volution is reached. The inner one is imperfect, but calculating from the rate of increase in size of the inner portion, there cannot have been more than two and a half volutions in all. The general features of the specimens would lead one to consider it a *Trochoceras*, but the form of the aperture is that of a *Lituite*, and on lifting a specimen from the matrix it is found to be coiled exactly on the same plane. It bears considerable general resemblance in form to *Trochoceras Desplainense*, McChesney, except in size; but in that one the undulations pass across and are strongest on the dorsum which is not flattened, and the coiling of that shell on one side, so as to produce a raised spire, at once marks it as a true *Trochoceras*.

This species might be considered as a representative of *L. giganteus*, Sowerby, (Sil. Syst. pl. 11, fig. 4.) the undulations of the surface are, however, very much stronger and almost twice as distant, and the flattening on the back of the shell much wider.

Formation and Locality.—The specimens were obtained from dolomite limestone of the Niagara group at Wabash City, Indiana, some years ago by Mr. Fred. Braun, of Cincinnati, Ohio; from whom they were purchased, with other fossils, by the Trustees of the Museum, and are now in the Museum collection.

[*Oct. 10th,*

ARTICLE XI.—*Notice of a very large species of Homalonotus from the Oriskany sandstone formation.* By R. P. WHITFIELD.

Family CALYMENIDÆ.

Genus HOMALONOTUS, *Koenig.*

Homalonotus Major, n. sp.

PLATE 22.

Two imperfect specimens of a species of *Homalonotus* were brought to the Museum some years ago, from near Kingston, New York, which were said to have been obtained from some shaly layers in the upper part of the Oriskany sandstone near that place. Mr. Louis Bevier, of Kingston, who brought them, presented one to the Museum; the other was to be deposited in the name of the discoverer in a local Museum at Kingston, New York. The specimen in the possession of the Museum, which is the smaller of the two, measures six and three quarter inches in length, and preserves the pygidial plate, imperfect at the posterior extremity, and the five posterior thoracic segments only. Calculating the length of the eight missing segments from that of the five preserved, and allowing for the cephalic plate a length equal to the pygidial plate, which is about the proportion they possess in other species, this specimen would have measured, when perfect, about fifteen and a half inches in length, with a breadth across the thorax at the fifth segment from the pygidium, of five and one-half inches; while the entire length of the one retained at Kingston must have been much greater. This, I think, is greater than the dimensions of any described species or specimen of the genus. Mr. Salter mentions a specimen of *H. rudis*, which, he says, must have been "a foot long when perfect."* These specimens are both flattened, in which condition they may be a little wider than natural; but the sides are bent down vertically, or slightly bent under for nearly an inch, which more than compensates for the flattening of the surface, so that the width is probably no greater, if not less, than in the natural condition.

The general features of the species are perhaps more nearly like those of *H. delphinocephalus* than of any other one known,

* Palæontographical Soc. Pub., Vol. xvii., p. 109.

unless possibly *H. Vanuxemi*, Hall, from the Lower Helderberg group, but we know so little of this last that no comparison can be instituted. As compared with the former species, both axis and lateral lobes of the pygidium are more strongly lobed, and the annulations more strongly marked, while the axial rings are arched forward, presenting an angulation in the center which I have never observed in that one, they being usually directed nearly straight across, or very slightly but regularly arched. The extremity of the pygidial shield has apparently been somewhat pointed, but whether as distinctly so as in that one cannot be determined. The thoracic segments cannot be said to differ materially from those of *H. delphinocephalus*, nor do these parts differ very materially among different species of the same type, under the genus. The form of the body, however, widens more rapidly from the pygidial plate forward than in that one, and the crust has been proportionally thinner. Especially is this latter the case between this and *H. DeKayi*, Green, from the Hamilton group, as is readily seen by the difference in the strength of the furrows left when the crust at the junction of any two segments has been removed; it being much greater in the *DeKayi* than in this species. The microscopical structure of the crust, although generally somewhat changed by the action of the weather, has been very similar to that of *H. delphinocephalus*, but in proportion to the size of the specimen there has been more punctures to a given space, and the intermediate surface is more strongly granulose.

In regard to the geological position of these specimens I can say but little beyond that given me by Mr. Louis Bevier, that they are from the upper part of the Oriskany formation. There are several fragments of Brachiopods on the back of the figured specimen, which is the only one I have in hand at the present time, but they are too obscure to be positively identified. One I think, however, is the young of *Strophodonta magnifica*, Hall, an Oriskany fossil. There is also a fragment of a trilobite tail which may have been a Dalmania like *D. pleuroptyx*, from the Lower Helderberg group. But it must be remembered, that along the range of these rocks from near Kingston to Port Jervis and southward, the Oriskany often takes on the shaly character of the Lower Helderberg to some extent, and also carries many of its fossils, so that the shaly character of the matrix, or a Lower Helderberg fossil will hardly invalidate the finders claim to its being an Oriskany fossil. The locality, as given with the specimen, is "Upper Oriskany, Cranberry Dam, 5th, Binnewater, Ulster County, N. Y., Louis Bevier." The "5th Binnewater" I suppose to refer to a dam of the Delaware and Hudson Canal Company's privilege on the Binnewater Creek.

EXPLANATION OF PLATES.

PLATE XIX.

Proscorpius Osborni.

These figures are from photographs of the specimen, natural size and enlarged.

PLATE XX.

Fig. 1. View of the specimen, enlarged four diameters. In this figure the line across the base of the head was made too distinct, and the eye tubercle too long behind, in tracing the figure. The line separating the fingers of the palpus extends too far down, and the spot representing the stigma-like mark on the fifth ventral segment is too distinct.

Fig. 2 *a*. The mandible further enlarged; *b* and *c* show it as seen in different lights.

Fig. 3. Outline sketch of the specimen, two diameters; 1, mandible; 2, palpus; 3, first walking limb; 4, 5 and 6, parts of the other limbs; *a*, the spot which may represent a spiracle; *b*, the additional ventral plate; *c*, one of the depressions in the integument which looks like a perforation.

Fig. 4. Outline representing Mr. S. H. Scudder's idea of the first walking limb.

PLATE XXI.

Lituites Bickmoreanus.

Fig. 1. Shows the form of the undulations on the dorsal surface.

Fig. 2. Lateral view of the specimen, showing the form of the aperture.

Fig. 3. Shows one of the septa.

PLATE XXII.

Homalonotus Major.

View of the specimen on which the species is founded.

ARTICLE XII.—*Description of a rare Squirrel, new to the Territory of Arizona.*—By EDGAR A. MEARNS, Assistant Surgeon, U. S. A.

Spermophilus (Ictidomys) tereticaudus BAIRD.

ROUND-TAILED SPERMOPHILE.

THIS interesting mammal was first taken at Fort Yuma, California, about thirty years ago, by Major G. H. Thomas, who forwarded four specimens to Professor Baird, which furnished the material for his original description of the species in "Mammals of North America," page 315, published in 1857. The head, feet and skull were subsequently figured by the same author in the "Report of the United States and Mexican Boundary Survey." These four specimens, I believe, have remained the only ones known up to the present time.* Upon the same specimens, Mr. J. A. Allen based his accounts of the species in his memoir on the American Sciuridæ occuring north of Mexico (Proc. Bost. Soc. Nat. Hist. XVI, Feb., 1874, p. 291), and in his Monograph of the American Sciuridæ, published in the eleventh volume of Hayden's "Geological Survey of the Territories," 1877. In the latter work, page 863, he states that "it is known as yet only from the specimens described by Professor Baird in his original account of the species, published twenty years ago.... They consist of one skin and a skull, and three examples in alcohol, all in rather bad condition."

Upon a recent occasion, when I rode in the saddle from Fort Verde, Arizona, to Deming, New Mexico, and back, a distance of over nine hundred miles, I became familiar with this and many other little-known species, and now present as complete an account of the animal and its habits as possible.

DIAGNOSIS.—In addition to the characters pertaining to Allen's subgenus *Ictidomys*,† to which this species belongs, it is to be distinguished by the following specific characters: Size small, about equal to *Tamias harrisi* inhabiting the same region; total

*[They remain the only ones thus far publicly recorded, but Mr. F. Stephens obtained several specimens at San Gorgonio Pass, California, early in April, 1885, some of which he kindly sent me for examination.—J. A. ALLEN.]

† "Ears generally small, sometimes rudimentary; tail long, cylindrical, or narrow and flattened, or quite broad, with the hairs one-half to three-fourths the length of the body; skull very long and narrow; first upper premolar usually rather small, and the dentition not heavy. Species, *S. tereticaudus*, *S. mexicanus*, *S. tridecemlineatus*, *S. franklini*."

length, 255 mm.; head and body, 162 mm.; tail, vertebræ, 78 mm., to end of hairs, 99 mm.; manus, 24 mm.; pes, 35 mm.; chest girth, 107 mm.; belly girth, 166 mm. Tail, with hairs, about four-fifths as long as the body without the head; terete, with hairs appressed, and scarcely expanded at tip. Ears reduced to a narrow rim. Feet broad and powerful. Palms naked in front, pilose behind. Soles of feet clothed with long hairs beneath. Muzzle pilose. Hair short, coarse and scanty. Above, pale yellowish-brown with a vinaceous cast; ventral surface, a circle around each eye, feet and inner aspect of legs, pure white; terminal portion of tail indistinctly annulated with black, whitish on circumference and at extreme end; otherwise of the same color as the back above, and a pale shade of the same below.

DESCRIPTION.—Professor Baird, in the original description of this Spermophile, makes an apt comparison between it and the "Prairie-dog," which is borne out not only by the color-pattern but by the rotund abdomen, shape and proportions of the animal, excepting the long tail of the former, and is especially applicable to the light yellowish phase of *Cynomys* inhabiting Arizona. The general color of the entire dorsum is uniformly pale yellowish-brown, with a slight pinky or vinaceous cast, finely grizzled with gray, and having a slight admixture of black hairs. The individual hairs are yellowish-brown, either pointed or annulated with gray, many of them black at the extreme base, some ringed with the same, and a few black throughout. Under parts of body, excepting the region around the arms, and including the inner surface of legs, pure white. There is no distinct line of separation between the colors of the upper and lower surfaces, the colors blending laterally. The feet are white, the color of the back extending downward on the outer side of the legs, and passing into white by an insensible gradation. The extreme tip of the nose and sides of the face are whitish, the latter faintly washed with yellowish-brown, and mixed with black hairs in an area below the eye, sharply defining the white orbital circle. The whiskers, lashes on lower lid, and a tuft of long hairs of similar quality above the front of the eye, black. Occasionally a few of the whiskers are white, or some are black at base and white terminally; this is probably an indication of old age. The rump and region around the anus are yellowish-brown ; the latter white in some specimens. Above, the tail is colored like the back, below a pale brownish-yellow, some of the hairs tipped with yellowish-white; its terminal portion—about two-thirds—is indistinctly annulated with black, whitish terminally and on circumference. The subterminal bar of black, mentioned in the descriptions of Baird and Allen, is not a very tangible or constant feature. The nail on the rudimentary pollux is distinct, and much more developed than in *Tamias harrisi.* The fore claws are considerably larger than the hind, the proportion being as 6.2 : 5 ; their color, brownish-black, fading to horn-color at tip. When perfectly fresh, the color of the inner surface of the skin is a brilliant purplish-blue. The winter pelage may prove to be more dense, longer and softer, as it is in *Tamias harrisi.* The testicles are abdominal, as in *Cynomys columbianus.* This is not usually the case with *Spermophilus grammurus*, nor the species of *Tamias* found in Arizona, so far as I have observed. There is but little sexual difference in the amount of development of the mammæ, of which there are always five pairs.

The type of the above description, amending the original one by Professor Baird and that of Mr. Allen, based upon the same specimens, is No. 169, ♂ ad., taken by me between New River and Phœnix, Arizona, on March 28, 1885.

The principal disagreement between the present description and those hitherto published consists in the statement that the tail is concolor with the body, both sides, and that the color below is yellowish- or brownish-white, whereas the under surface of the body is *pure white*, and the under side of the tail brownish. The discrepancy may be due to the original specimens being earth-soiled or stained* by the preservative fluid in which they were immersed.†

CRANIAL AND DENTAL CHARACTERS.—On comparison of skulls of this species with those of the other Arizona Sciuridæ, the only material now at my command, comprising two typical *Sciuri*

*[Doubtless due to discoloration from long immersion in spirits, since specimens sent me (see p. 197, foot note) from San Gorgonio Pass, California, have the lower surface pure white, and the lower surface of the tail brown, as in Arizona specimens.]

† The under surface is quite thinly coated with hair, permitting the skin to be seen in places; in some specimens the axillæ are entirely naked. The bare skin is yellow in dry specimens; but every hair is pure white.

(*Sciurus hudsonius fremonti* and *S. aberti*), *Tamias asiaticus et vars.*, *T. harrisi*, *Spermophilus grammurus* and *Cynomys columbianus*, all are found to have the same dental formula, viz.: I. $\frac{1-1}{1-1}$; Pm. $\frac{2-2}{1-1}$; M. $\frac{3-3}{3-3} = \frac{12}{10}$. The chief variation in dentition consists in the form and relative size of the molar series, especially in the upper first two premolars, together with the direction of insertion and relative position of the molar series of teeth on the two sides. In these respects the species named form a continuous series in the order mentioned (*Spermophilus tereticaudus* falling in with *S. grammurus*); beginning with the *Sciuri* in which the first premolar is minute and functionless, or even occasionally deciduous in *S. hudsonius fremonti*, becoming slightly more pronounced in *Tamias asiaticus dorsalis* and in *T. harrisi* (which "favors" the *Spermophili*), until, in *Spermophilus grammurus* and *C. tereticaudus*, it becomes a serviceable grinding-tooth, and in *Cynomys*, where it reaches its maximum development, measures quite as much antero-posteriorly as either of the three neighboring teeth, the last molar being enormously developed. In like manner the molar series undergo a change, more or less gradual, from the *Sciuri* in which the molar series are exactly parallel and but slightly oblique in their insertion to *Cynomys*, in which the teeth are inserted very obliquely, and converge posteriorly until the first premolars are separated by twice the distance between the last molars.

In *Spermophilus tereticaudus* the first premolar is a small but efficient tooth, about twice as large as that of *Tamias harrisi*, and, relatively, rather more developed than in the sciurine *Spermophilus grammurus*. Its dentition, as a whole, is considerably heavier than in *Tamias harrisi*, with which *Spermophilus tereticaudus* is properly to be compared on account of the spermophiline affinities of *T. harrisi*, and, relatively, than in *S. grammurus*. The teeth are more obliquely inserted than in either.

Deferring any elaborate comparison of the skulls until the occasion of treating of the Arizona Squirrels as a whole, the salient cranial characters may be said to consist in the narrow and elongated skull, convex above, with the malar arch but moderately expanded, and the interorbital region much contracted, as in *Cynomys*. The postorbital process is strong, triangular, and directed downward and backward; anteorbital foramina large, oval, and protected by a strong bony process below; plane of the malar turned completely outward, instead of obliquely as in *Tamias*.

I am debarred from comparing the skulls of *S. mexicanus* and *T. lateralis*, which connect this species with the genus *Tamias;* but *S. tereticaudus* differs from *T. harrisi* in having the dorsal outline more convex, the interorbital space contracted, the anterior outline more obtuse, the malars more expanded, the brain cavity much less inflated, the skull more depressed behind, the postorbital process broader and less depressed, and the surface roughened with ridges for muscular attachment. As noted above, the dentition is much heavier. Its relationship can be better understood by reference to the accompanying table, expressing the ratio between the dimensions of certain parts of the skull and its total length in all of the species above mentioned.

HABITAT.—Although previously known only from Fort Yuma, California, the Round-tailed Spermophile inhabits quite a wide area of our southwestern territory.

When marching toward Texas, from Fort Verde, in Central Arizona, I first met with this Squirrel when eighty miles southwest of Fort Verde, near Hall's Station, on New River, just within the northern limit of Maricopa County, on March 28, 1885; and we saw them every day of our march thereafter until we reached Frisk's ranche, twenty-two miles northwest of Bowie Station, in Pima County, Arizona, on the 8th of April. It was next noted in a greasewood tract, about six or seven miles in extent, west of Lordsburg, New Mexico, none having been actually seen on the intervening sixty miles of our march, although its presence was suspected. Fifty miles were again traversed without any positive proof of its presence, and I began to think that we had crossed the boundary of its habitat, when it again appeared several miles west of Deming, New Mexico, and was afterwards found to be abundant in the immediate vicinity of that town.

Returning over the same route (except from Railroad Pass to Mountain Spring, Arizona, a distance of seventy miles), I observed this species from Deming to Separ, New Mexico, from Lordsburg, New Mexico, to San Simon, Arizona, and at Bowie Station, where we remained in camp on April 30; thence, for a distance of two hundred and sixty miles, to within a few miles of Hall's ranche, on New River, where we returned on the 15th of May, 1885, the Round-tailed Spermophile was observed every day of the march, and was generally abundant. From its colonial mode of residence, there are often considerable areas over which none are found, but, in general terms, the species may be said to inhabit the entire line of our march, from New River, Arizona, to Deming, New Mexico, a distance of three hundred and seventy-seven miles. From descriptions given me of a "gray" or "yellow gopher" by persons who have traveled in Mexico, I believe that this species will be found to extend all the way across Western Sonora, to the coast.

The southern part of California, including the peninsula, the southern third of Arizona, excluding the higher altitudes, the western half of Southern New Mexico, and the Mexican State of Sonora, will probably be found to include the whole or greater part of the habitat of *Spermophilus tereticaudus* and its varieties, if any.

HABITS.—We first found the Round-tailed Spermophile on the 28th of March, 1885, in a wide zone of greasewood and cacti, when crossing a level desert between New River and Phœnix, Arizona, bounded by barren mountains rising abruptly from the plain, and covered with volcanic rocks.

The first one seen was crawling stealthily through some weeds, its body depressed, head elevated, and presenting such a musteline appearance, that I believed it to be a veritable Weasel until I stooped to pick up the specimen after killing it. Several others were shot during the day. At Desert Well, about the middle of the day's march, we found Harris's Chipmunk associating with the newly-found Spermophile, whose range it overlaps upon the edge of the desert; but the locality was at the base of a mountain piled with malapai rocks, in which the Chipmunks found a congenial home, quite different from the adjacent plain in which the Spermophile is so abundant.

In the torrid, sandy, desert region south of the Gila River, the Round-tailed Spermophile is the most abundant and characteristic mammal. This singular species lives in holes under the greasewoods, which they undermine, excavating chambers, and tunneling beneath the roots. They form large, low mounds around the bases of the greasewoods, providing many holes for ingress and egress. This site for their dwellings seems to be selected for the reason that the meshes formed by the fine roots of the greasewood serve to support the dome of their habitation; the soil being everywhere light and loose, would otherwise be continually caving in upon their numerous chambers and galleries.

This species must be infinitely abundant in the region which it inhabits, for they live in immense colonies. In many areas, every greasewood bush had their burrows beneath it. In habits, they are shy. At a distance, they were very often seen sitting up erect like "Prairie-dogs" (*Cynomys*), at the entrance to their burrows. As soon as they saw us, they usually dived into one of several holes generally found beneath the bush, which, in this region, was always a greasewood, as that is the only abundant shrub growing upon most of the desert. In Southeastern Arizona, however, especially along the San Pedro River, their mounds were frequently seen in open, grassy places, and were usually large and high, much resembling large ant-hills, which, indeed, they may originally have been; but at Deming, New Mexico, they lived almost exclusively in mounds beneath the mesquite bushes, and fed upon the fruitage of that plant.

When surprised away from home they try to skulk unobserved to their holes, crouching low and elevating their heads, which they poise horizontally, always furtively eyeing any human intruder. Its resemblance to a Weasel at such times is very striking. If conscious that it has been discovered, it runs behind the nearest bush, alternately making advances toward its burrow and seeking concealment behind a tuft of grass or weeds. Those shot had been eating the seeds of a hispid weed, bearing yellow flowers. Their huge stomachs were so distended with food that they had the appearance of being about to bear young. They utter a low, plaintive whistle when disappearing into their burrows. One kept popping its head in and out of a hole, uttering this sad note at each disappearance. It is hard to shoot them owing to their shyness, and the difficulty of seeing them upon the dazzling sand of their tropical home before they reach their holes, into which they scurry on the slightest alarm, but often pause and sit up at the entrance before slipping in, giving an opportunity for a quick shot from the saddle. Near the Pima Villages, on the Gila River, they were abundant, and were a favorite mark for the arrows of the Indian urchins. One old Indian seemed to take great pleasure in seeing me shoot at them from my horse. He would ride ahead and point them out, and was able to see them at a surprisingly great distance.

The Round-tailed Spermophile is exceedingly abundant in and about Fort Lowell, where its association with man has made them far less shy than those living in the desert away from human habitations.

When returning into Arizona, across the New Mexico line, we found these Spermophiles abundant, although none were seen when passing over this portion of the route before, and their lisping whistle was constantly heard. The species, in fact, was abundant at intervals throughout our line of march from New River to Deming; but its existence would be patent to a casual traveler, more from the presence of their burrows, and their soft whistle, whose source he would be apt to look for in vain, than from frequent sight of the animals themselves.

Although eminently fossorial, this animal is endowed with latent scansorial proclivities, which are brought out by the sight of food in elevated situations. In other words, they will climb for mesquite beans. I caught one in the very top of a mesquite, by creeping unobserved to the bottom of the tree; seeing its means of escape cut off, the poor creature became so paralyzed with terror, that I had no difficulty in climbing up and taking it in my hand. I carried it safely home to Fort Verde. It drank eagerly, although inhabiting a region where water is seldom found. It ate corn and mesquite beans with avidity, and was a lively and agreeable pet.

Their young are brought forth in the subterranean burrows, which I regret not having had time to examine with sufficient care to describe exactly. Young, but a few weeks old, were seen upon the surface with their parents on May 15, and must have been born late in April.

DIMENSIONS* OF SEVEN SPECIMENS OF *Spermophilus tereticaudus.*

Collector's number.	Sex and age.	DATE. 1885.	LOCALITY.	Total length.	Head and body.	From tip of nose to: Eye.	Ear.	Meatus.	Tip of ear.	Occiput.	Tail to end of: Vertebræ.	Hairs.	Manus.	Pes.	Fore leg.	Hind leg.	Height of ear above skull.	Height of ear above meatus.	Distance between eyes.	Chest girth.	Belly girth.	Longest fore claw.	Longest hind claw.
168	♀ ad.	Mar. 28	Near Hall's ranche, on New River, Arizona.........	265	173	17	34	36	41	45	74	92	24	35	48	68	4	8	22	110	165	6.7	5
169†	♂ ad.	" 28	Between New River and Phœnix, Arizona	272	165	16	34	36	40	44	85	107	24	36	50	68	3	7	22	110	170	6	4.5
170	♀ ad.	" 28	Between New River and Phœnix, Arizona.......	250	160	17	32	33	38	43	72	90	23	33	46	63	4	7	23	105	175	6.5	5.2
171	♂ ad.	" 28	Between New River and Desert Station, Arizona,	257	166	18	32	34	39	43	73	91	23	34	47	63	3	7	24	112	175	6.9	5.1
172	♂ ad.	" 28	Between New River and Desert Station, Arizona,	270	155	17	32	34	38	42	85	115	25	35	48	66	4	7.5	23	110	175	7	5
174	♀ ad.	" 30	Near Maricopa, Arizona....	257	160	15	30	31	37	41	77	97	24	34	49	64	3	7	22	105	170	5	4.1
195	♂ ad.	May 23	Desert Station, Arizona.....	217	159	17	32	34	41	43	‡	§	26	37	51	70	3	8	22	95	180	5.3	5.5
Average...............				255	162	17	32	34	39	43	78	99	24	35	48	66	3 5	7.4	22.6	107	166	6.2	5
Maximum........................				272	173	18	34	36	41	45	85	115	26	37	51	70	4	8	24	112	175	7	5.5
Minimum..........................				217	155	15	30	31	37	41	72	90	23	33	46	63	3	7	22	95	130	5	4.1
Average in inches and hundredths........				10.04	6.38	.67	1.22	1.34	1.54	1.69	3.07	3.90	.94	1.38	1.89	2.60	.14	.29	.89	4.21	6.54	.24	.20

* Taken from fresh specimens, in millimeters.
† Type specimen.

‡ 46 mm. } The end has been broken off.
§ 58 mm. }

MEASUREMENTS* OF EIGHT SKULLS OF *Spermophilus tereticaudus.*

Collector's number.	Sex and age.	Locality.	Total length.	Greatest breadth.	Distance between orbits.	Nasal bones, length.	Nasal bones, width behind.	Nasal bones, width before.	Upper incisors, from front to molars.	Upper incisors, from front to hinder margin of palate.	Upper incisors, height.	Upper incisors, width between external edges.	Upper molars, length taken together.	Lower jaw, length.	Lower jaw, greatest height.
168	♀ ad.	Near Hall's ranche on New River, Arizona......	37	23.5	8.5	12	3	4.6	10.2	19.2	5.4	4.1	8	22.5	13
169	♂ ad.	Between New River and Phœnix, Arizona......	39	24.5	8.5	12	3	5	10.2	20.5	5.2	4.2	8	23.9	13.5
170	♀ ad.	" " " "	36.5	23.8	8	11.5	2.8	5	10	20	6	4.1	8	23.5	12.1
171	♂ ad.	Between New River and Desert Station, Arizona.	37.5	24	8.4	12	3.3	4.6	11	20	6.3	4.3	7.9	23.3	12.5
174	♀ ad.	" " " " "	36.5	23	9.5	11.9	3.5	5	11	20	6	4.2	8	23	13
195	♂ ad.	Desert Station, 14 miles north of Phœnix, Arizona,	39	24	9	13	2.9	4.1	11	20.7	5.6	4	8	23.4	13
227	♀ ad.	Fort Lowell, Arizona..........................	36	22	8.6	11	3	4.4	10.7	19	6	4	7.6	22.3	12
228	♂ ad.	Desert Well, 20 miles north of Phœnix, Arizona..	39	24.2	9	13.6	2.2	5	11.9	20.2	7	4.5	8.1	24	12.3
Average................................			37.6	23.6	8.7	12.1	3	4.7	10.8	20	5.9	4.2	8	23.2	12.7
Maximum................................			39	24.5	9.5	13.6	3.5	5	11.9	20.7	7	4.5	8.1	24	13.5
Minimum................................			36	22	8	11	2.2	4.1	10	19	5.2	4	7.6	22.3	12
Average in inches and hundredths........			1.48	.93	.34	.48	.12	.19	.42	.79	.23	.17	.31	.91	.50

* The measurements are in millimetres. If desirable, for comparison, reduce to inches and hundredths by dividing by 25.4.

Table showing the ratio between the dimensions of certain parts of the skull and its total length, in eight species and varieties of Arizona Squirrels.

NAME.	Total length, in millimeters.	Greatest width.	Distance between orbits.	Nasal bones, length.	Upper incisors from front to molars	Upper incisors from front to hinder margin of palate.	Upper molars, length taken together.	Lower jaw, length.
Sciurus arizonensis,	64.8	.581	.33	.336	.295	.50	.186	.59
Sciurus aberti,	59.5	.57	.33	.35	.29	.49	.18	.58
Sciurus hudsonius fremonti,	48	.59	.34	.31	.30	.51	.17	.59
Tamias asiaticus quadrivittatus,	31	.54	.25	.32	.30	.47	.16	.54
Tamias asiaticus dorsalis,	37	.55	.24	.31	.30	.47	.16	.57
Tamias harrisi,	39.6	.58	.26	.29	.31	.53	.18	.59
Spermophilus grammurus,	61	.66	.26	.35	.33	.56	.20	.64
Spermophilus tereticaudus,	37.6	.63	.23	.32	.29	.53	.21	62
Cynomys columbianus,	65	.677	.215	.385	.27	.55	.27	.69

ARTICLE XIII.—*Notes on the Life History of Amblystoma opacum.* By Colonel NICHOLAS PIKE.

WHEN I first began to study the life history of this species of *Amblystoma* I found but little had been written on the subject, and many of the facts given appeared to my mind very singular. In the "Ninth Annual Report of the Smithsonian Institution," Washington, page 294, is a letter from Gloucester, Virginia,* sent to the Secretary, with nest, eggs, etc. The account is so remarkable that I give the gist of it here. The writer says:

The localities in which the animals were found were the beds of small ponds in the woods, which in rainy weather have water in them, but were dry when he obtained the eggs. Later he visited the ponds and found water in them from recent rains, and saw only one pair, and they ran into the water. The writer speaks of sending their *nests*, with the specimens he procured from a hollow in the surface of the earth deeply covered with leaves, and under which were tunnels extending in various directions. In these hollows he found the animals curled up over their eggs. Under one he found one hundred and eight eggs in the month of December. The young in these eggs were so far advanced that they were in motion as soon as released from the embryonic covering. The specimens were taken twenty or thirty feet from the ponds, and tunnels were noticed, like those of moles, extending from the nest under leaves, as if they were for the animals to hunt along for food. The writer observes, however, that no small ones have ever been taken away from the water, except the very young ones sent, which came from the broken eggs.

The above account is so totally different from my own experience that I can only conclude some mistake was made. I cannot believe the eggs found under the animals were their own, as I can satisfactorily prove that (at least on Long Island) the *Amblystoma opacum* is hatched, and lives, in the water during its early life. It is utterly surprising to me how the young, said to have been sent from the broken eggs, could have been identified so early, and still more wonderful that there were shells that could be broken. Even an expert who has bred them can with difficulty identify the

* On the habits of a species of Salamander (*Amblystoma opacum* Bd.).—By the Rev. Charles Mann, Ninth Ann. Rep. Smith. Inst., 1854, pp. 294, 295.

very young. The mistake has doubtless arisen in the same way that other statements relative to this genus have been given to the public, from conclusions too hastily made; and this is to be regretted, as it only leads the student astray.

The Marbled Salamander, like all of its genus, is mostly a night prowler, rarely seen abroad in the day, and it was some years before I could speak with precision of its life history. In the latter part of March, 1880, soon after the ice left the ponds, I noticed some very small larvæ of a Salamander swimming about, and succeeded in capturing a few, which I brought home alive. They were not more than one-half an inch long, with large heads for their size, and quite unknown to me. They only lived a few days, but I carefully preserved them in an alcoholic solution. I hunted for more in vain, till 1882, when I procured others still smaller, evidently only recently hatched. At the same time I fished up a bunch of eggs similarly enveloped in a glairy mass to that of *A. punctatum*, but the mass was not attached, but floating in the water, and appeared to have been deposited but a short time. I took the precaution to bring home a quantity of vegetable *débris* from the ponds with them, and placed the whole in a large tank; and at this time I really thought I had the young of *A. tigrinum*. The eggs appeared to me a little larger than those of *A. punctatum*, and the light pole of all was of a dingier hue; their development was similar, and they curled up in the embryonic sac much in the same way. In about fifteen days the young emerged, and were swimming about in the tank, keeping close to the remains of their late envelope, which for some time appeared to afford them food. When first hatched they are of a dingy brown above and whitish underneath, with a faint row of white dots bordering the abdomen, and another row half way between it and the dorsal fin. When a month old they were excessively active, darting about when I approached the tank, and hiding under leaves till I left.

I kept up a good supply of weeds and dead leaves from the ponds, and whenever I brought it home, the little creatures would dart about busily and evidently found abundant food; as some that died, and which I dissected, were full of insects, larvæ, minute monads, etc.; but they were nearly two months old before they took the small Physas I procured for them.

When barely an inch long the fringes of the gills are reddish, and the tail-fin is edged black, the rows of white spots prominent, and the head broader and flatter. The gills are full and feathery, generally carried erect, which gives the little creatures quite a fierce aspect. About the 5th of May, when half an inch long, the tail lost its fin and tapered to a point, the branchiæ were nearly absorbed, and it was so curiously marked even at this age as to be difficult to place it by any resemblance it has to any Salamander I know. The whole body becomes covered with white dots and spots, as if flour had been thrown over the animal. At this stage of growth it has the distinguishing mark of a large white patch on the junction of the fore-arm with the body. Very soon the lateral spots become faint, but the abdominal row very prominent, and the color underneath darkens.

As soon as the branchiæ are absorbed, the little creatures become restless, always trying to escape, and if not taken from the water they die; at least that is my experience in breeding them. I prepared for them a box filled with damp moss and dead leaves, wherein they soon curled down, to all appearances contentedly; but, shy as they seem, if the netting was not tied securely down, some would escape.

The changes are now curious and rapid. By July 4, the mass of white dottings began to break up, and a little black showed on the back, and especially on the tail, the latter flattening out. On the 22d, the dorsal bands were plainly visible; and by the 29th my little pets were perfect miniatures of the adults in color and markings, to my great delight. From the time of hatching the eggs to the well-developed, well-marked animal, about two and one-half inches long, it takes about four months and a half; a little more or less according to weather, food, and other circumstances. In October, I placed a number of young in a large glass jar partly filled with moss, and put it down in the cellar where they lived till the following spring, but their growth was scarcely perceptible.

I have in my cabinet a series of specimens from the egg up to the perfect animal, and at the present time (August, 1885), I have some lately developed that I have reared this season from some larvæ taken May 3, 1885, when about three and a quarter inches long. They have thrived well with me; in fact, better than most

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of the other Salamanders, for they are so vigorous and healthy.

The *A. opacum* is strictly a land animal, never going near water except to breed, and then mostly at night. I have never seen the impregnation and passage of the ova, but believe they are the same as with *A. punctatum.* I once saw a pair *in coïtu* about sundown, but they darted away so rapidly on my approach I could not capture them.

Like most batrachians, when the adults leave the water, they rest for some time, hiding away without food until their strength is restored, when they seek higher lands, and resume their terrestrial habits. I have often trapped them in deep holes, where I suppose they had fallen in their night prowlings, with just a slight covering of earth over them. In confinement they refuse food for sometime, and lie curled up head to tail, scarcely moving from their position for two or three weeks. I see my young act in the same way as the adults. No matter what time of the day I look at them, they are always curled up in the same corner of the box; yet I know they move about at night, for I see the small bivalves I put in for their food are always eaten, yet I never saw one taken. I think it takes over four years for this animal to mature. The adults are rather slow in their movements, so entirely different from the larval stage when in the water, as they are then the most active of their genus and not easy to catch. The old ones when caught are shy and quiet, and will curl up on the hand without trying to escape.

The *A. opacum* does not hibernate very early, but hides under leaves till the first sharp frost sets in, when it burrows down from twelve to twenty-five inches below the surface. Where the ground is very soft I have dug them out three feet down, but this is a rare occurrence. Where attainable, they prefer cavernous places for hibernation, and may be occasionally found under large stones, or buried deep in the *débris* of old tree stumps.

Some workmen who were removing the concrete covering, the stones of which formed the foundation of a roadway, found in a hole a number of *A. opacum* and *A. punctatum*, and a solitary *Spelerpes longicauda.* Old and young, all lay in a heap together, thus proving their gregarious habits. These animals had crawled under the concrete from the bank of a swampy pond that the road skirted.

Article XIV.—*Notes on the Hermit Spadefoot* (*Scaphiopus holbrookii Harlan; S. solitarius Holbr.*). — By Colonel Nicholas Pike.

The study of the habits of the *Spadefoot* (so called from the animal using its hind feet in digging) has always been one of great interest to me. The harmless little creature is still not uncommon, *if you only know where to find it.* There lies the difficulty—so few do know—and, excepting some naturalists, very few would distinguish it from a common toad. It must of course be hunted for in secluded places, and woody hill-sides, but I will venture to say that even the most knowing, in nine cases out of ten, will only find a Spadefoot by accident.

Many years ago I had several in my garden which became quite tame, and would allow me to take them in my hands. They made circular holes in the ground about six inches deep, somewhat turnip shaped. A few minutes sufficed for them to burrow out of sight. The long feet, with the horny excrescence serving as an additional toe, and the strong curved fingers enable the Spadefoot to make the excavation rapidly. This is not by any means the completion of its home. The inside has to be worked smoothly, and the earth prevented from falling in.

This is done by the animal working its body with a circular motion, and the operation would go on for an hour or more, and the liquid exuding from its pores worked into the earth made it smooth, and formed a curious little dwelling when completed. Round the top was a layer of viscous matter, and woe betide any unwary insect that alighted on it. Closely concealed lay Spadefoot, only the bright eyes visible, ever on the watch, and unerring in its aim when any luckless fly intruded on the threshold. They appeared to be greedy feeders, and I often amused myself by giving them insects, which they seized with avidity as long as I supplied them.

This I find is the usual summer residence of the Spadefoot, and when once domiciled, it rarely leaves home in the day-time. No two ever inhabit the same hole, hence the name Hermit Spadefoot, or *solitarius.*

When sharp summer rains fell they would quit their houses and seek shelter under plants, but would not return to the holes they had left. As soon as it was fine, about sunset or in the night, new homes were constructed with great rapidity. In the fall, very heavy rains set in and one by one my pets disappeared, generally in the night, and though I searched diligently for them I could not find their hibernaculum, and presume they burrowed away under the fence.

Thirty-five years ago I exhibited one of these habitations, which was made in a box sunk in my garden, with the animal in it, and read notes on it which were published in the proceedings of the Brooklyn Natural History Society.

The *Scaphiopus* changes much in color at various seasons. I have taken this animal late in the fall when it might easily have been passed by as only a dingy young toad, but for the curious eyes which will always identify the Spadefoot, no matter what its dress. The irides are mottled gold and brown, and are divided into four parts by a notch at each quarter, giving a lozenge shape to the large black pupil.

Quite late in November, 1883, I dug one up from about a foot below the surface of the earth, which was covered with decayed leaves. The head was smooth dark brown, and the whole body a dingy dark olive, with faint lines running from the eyes along the back, converging to a point at the rump. Every part of the animal was tubercled, even to the eyelids, and the parotid glands were greatly swollen. When first taken there was an orange tint over the thighs and hands, but this soon faded in confinement.

The little fellow took kindly to its imprisonment, grew very tame, and looked quite comfortable in its large glass jar half filled with damp moss. Sometimes when the moss seemed too wet I put in a lot quite dry. The cunning animal would look at it, toad like, with its head on one side, and take in the situation at once. It set to work and in a few minutes made a pretty little arbor, quite thick behind but so thin in front that it could see through the moss. It never appeared quite torpid, but only sound asleep at times, and would wake up quickly if disturbed. A favorite position of my Spadefoot was to crouch down flat with the hands turned in under the chin, the feet turned up, and the long toes resting on the elbows.

In April I took it out and found it as fat as when its winter rest began, although it had not tasted any kind of food for over six months.* During this long quiescence its coat had changed. The centre of the back was a bright sandy color with a large dark irregular star edged with black. The whole back and legs were heavily tubercled with a vivid red, chin white, abdomen and inside of thighs a reddish purple.

When the cold nights of fall begin, the Spadefoot leaves its summer home and looks out for one more suitable for the winter season. It generally chooses the warm southerly side of a hill, and excavates deeply for its new quarters. It was only after many years' studying of this animal that I was able to verify this fact.

About four years ago I found one by accident in winter, over three feet below the surface. On December 27, 1884, I was in Cypress Hills Cemetery when a laborer who was digging a grave called my attention to a toad snugly imbedded in the side of an opening he had just made. His spade had slightly grazed the body of the animal, which I saw at once was a Spadefoot. I asked him not to disturb it till I had made a careful examination of the burrow. The man had dug down nearly four feet, but the distance the creature had burrowed was by exact measurement three feet two inches.

The most careful search round the hibernaculum failed to discover any outlet. It had left no trace of burrowing behind it, having evidently covered up all tracks to its lair. The soil was packed closely about it, and the round hole was perfectly smooth, just large enough to contain the body in the crouching posture I mention its assuming in confinement. I have since been told that the Spadefoot has been found at a depth of six feet, but this I cannot vouch for.

When the weather is not too severe, even while the last snow is still on the ground, the *Scaphiopus* often makes its appearance, but then it only roams aimlessly round, hiding under dead leaves and taking little food. The usual time of awakening to renewed spring-life is the end of April or beginning of May, and if the weather is unfavorable, not till June or even July.

* In autumn the *Scaphiopi* feed voraciously and become very fat, and this seems to keep them in good condition till spring again brings forth their insect food.

This animal has as great a repugnance to water as the common *Bufo*, but like it is impelled towards this element in spring for the propagation of its species. In the "Synopsis of Batrachians of Arizona," by Dr. Elliott Coues, he states that the *Spea hammondi*, or *Scaph. hammondi*, was taken *in coïtu* in June, 1864, near Fort Wingate, New Mexico, at a considerable distance from water, but I know our Long Island *S. holbrookii* never mates otherwise than in the water.

Though I have had an intimate acquaintance with the Spadefoot, and studied its habits so long, and had it often in confinement, yet not till this year have I succeeded in breeding it. In 1884, when in correspondence with Dr. Charles C. Abbott, he sent me a paper he had published on this animal, in which he states that on April 10, 1874, a colony of Spadefoots suddenly appeared in a sink-hole in a dry upland field and remained till the 15th and then disappeared. Ten years later, May, 1884, they came again to the same locality, and left in a few days, yet nothing had been seen of them in the intervening years. On June 25 and 26 a violent storm filled the sink-hole, and in the afternoon of the later date the place was alive with them, every one uttering its ear-piercing notes. By the morning of the 28th not one was to be seen or heard. During this brief interval they spawned, attaching the eggs to blades of grass, etc. They hatched by the 2d of July, and by the 9th had their hind legs developed. On the 16th the front legs were out, tail diminished, and on the 25th they burrowed an inch below the surface of the earth he had placed in his aquarium for them.

This was very rapid development, but Dr. Abbott says they perfected three days earlier in the sink-hole.

In the account of the *Scaphiopus* in the "Essex County Journal of Natural History," by Andrew Nichols, M. M. S. S., President of the Society, this gentleman states that in Danvers, Mass., about the years 1812 and 1825, after a great rain in summer, and on August 12, 1834, and again on June 16, 1842, the Spadefoots appeared for breeding purposes, never being noticed in the intervening years—a most remarkable fact.

This animal is a most difficult subject to work upon to gain its life history, from the extreme uncertainty as to its whereabouts at all ages. In all the years I have known the Spadefoot, and in all my rambles every month in the year, it was not until August 8, 1884, that I was fortunate enough to see an exodus of these animals from the water.

I was strolling leisurely homewards with my wife after a long, enjoyable tramp in the woods, when on skirting the side of a hill rising from a pond we saw some little toads hopping across our path. They looked such mites we thought we would take a few as specimens of toads at that age for my cabinet series. My wife stooped for some, but on handling them she cried out, "Oh, come here, they are all pretty little Spadefoots."

Down went our baskets, fatigue and sunset were forgotten, and we gathered them in till the growing darkness compelled us to desist. Thousands of the little creatures were leisurely trudging up the steep hill, and the exodus must have been going on for hours, for many had reached the summit and were scattering in all directions, whilst others were still leaving the ponds. We carried our little treasures home in bags filled with grass, and so tired were we after our hunt we left them imprisoned all night. Some of them objected to being bagged, and made a faint squeaking noise when handled.

Next morning I placed them in a large glass jar with earth, and in less time than it takes to write the fact most were buried, all but their noses. I fed them on flies and insects, and once I put in half a nest of young spiders. As soon as their little bright eyes caught sight of the moving game, a most animated scene took place. Every one was out jumping and capering about till not a spider was left, when back they all hastened to hide till new victims were provided. I turned many into the garden in the hope that I might see some come out this spring. I was, however, disappointed, and it was not until August 24 that by accident I discovered any were alive. On the night of the 22d, and all next day, heavy rain fell, which washed the poor little fellows out of their homes and revealed their presence to me.

Two days after the exodus we visited the same hillside, but with the exception of two or three belated in the pond, not one was visible. We hunted diligently for them, dug in all sorts of places, turned over heaps of stones, but all in vain; yet I do not doubt there were hundreds buried all around us had we only known where. It is evident they go far from their first watery home, for they were marching steadily on, the column spreading out about fifty feet wide with none beyond it. Nor do I think they feed during the exodus. I saw an immense number of very small crickets in amongst them, but though I looked carefully I could not see any of the little Spadefoots eating them. When they leave the water they are smaller than the common toad, but if the season is favorable they grow rapidly in width more than in length. I have some two years old one-quarter of an inch in length, and nearly as wide as long.

This year I calculated about the time it would have taken the little Spadefoot of last year's catch to perfect, and I haunted the same spot for days in vain. Men who had been working near by the whole month told me there had been no sound of them, and it is quite certain they must have heard them had the ear-piercing screams been going on, which Dr. Abbott says can be heard half a mile away. Not a vestige of egg, tadpole or young have I seen in the spot where thousands were hatched in 1884. I shall watch curiously to see how long it will be before they re-appear in that locality.

As I said before, the Spadefoot has a great dislike to water, and when forced to it for breeding purposes does not remain in it long, from three to five days at most. The embrace often takes place on land, as it does occasionally in toads, so that they only enter the water for the act of spawning. Their wonderful screaming chorus is kept up the whole time the animals are *in coïtu*, and is the love song of the males, the females having only a low guttural grunt. As soon as possible the sexes separate and seek their summer homes, where they lead solitary lives till they have to seek their winter's retreat.

On the ridge extending from East New York to Jamaica, one of the most elevated parts of Long Island, there are ten or twelve ponds, some fed by springs and constant, others only filled by winter's snows and rains. This spring I worked them all over with my net, and though I heard no screeching, yet as the *Scaphiopus* is far from rare on the hills near by, I felt sure they must breed in some of these ponds. Toads, I know, also swarm in the vicinity, and on the 17th of July I fished up what I took to be toad spawn, although not in chaplets, and only slightly attached to some weeds floating about in the water. The eggs were evidently laid only a few days before, and I brought them carefully home.

The first week I had them was warm and sunny, and in about seven days the first tadpoles appeared, but a gloomy cold spell following, the rest did not hatch out under twelve and even fifteen days. At this stage they look black in the water, but are really brown. In about ten days the color broke out into blotches, with little white scattered dots. Certain signs at this time led me to suspect I had found a treasure, and the metamorphosis was watched with renewed interest. Having bred toads, and my cabinet containing a series of these tadpoles of different ages, I soon found a difference between them and my new acquisitions.

The toad tadpoles are oval, of a dusky black, with a clear white fin on the tail. The Spadefoots are brown and chubby, the tail narrow and blotched all over. Then they swim differently; the latter with the body depressed, and they skim around the aquarium with the greatest rapidity. The tadpole is of good size before the hind legs develop, and the back and abdomen gleam with gold; the latter is dark gray, the former brown, with dark marks on it showing the outline of the star of the adult starting from a broad dark disk between the eyes.

As soon as the hind legs are out, both body and tail diminish, and they are as ravenous as other tadpoles, devouring both meat and fish greedily. As soon as the thread-like front legs show, they must have cork or chips to sit on, as their perfection is close at hand. I neglected this at first, and some that were ready to leave the water August 18, actually atrophied till they were barely an inch long from snout to hind toe, the smallest live reptiles I ever saw, and died evidently from inability to remain in their watery home. It was only by giving them resting places, and a way out into a dry house, that I succeeded in bringing out strong young ones; and the first act of their terrestrial life seems to be to provide a home by burrowing.

When the front legs are well out in the toad, the whole under part assumes a yellowish-white hue, the thighs are finely granulated, and on the insides of the hands and feet the joints are thick and white. From between the eyes and all over the back are the outlines of the future warts, increasing in size daily. When the Spadefoot is at the same stage of growth the whole underneath is dusky gray; feet and hands are slighter and smoother; the body more drawn in behind the arms, and the tail is narrower.

When perfect, the little Spadefoots linger a little while on the long grass and weeds at the margin of the ponds to gain strength for their exodus. By this time, small as it is, it has all the makings of the adult, and crouches on the ground in the same way.

I do not quite agree with Mr. Nichols that "as they are southern reptiles chilled by our northern climate they want a more genial season to celebrate their nuptials, and thus with a suitable pond to receive their spawn, year after year transpires until a summer freshet has filled their native habitat sufficiently for spawning to take place."

In the pond where I found them in 1884 there was abundant water in 1885, fed by springs, and to my eye the same conditions obtained this year. It is evident Spadefoot thought differently, and resorted to a pool a quarter of a mile away, for some reasons unknown to me. I believe they breed every year, but change their locality, as the winters, though often severe on Long Island, certainly do not diminish the numbers of the *Scaphiopus*.

Article XV.—*A Revised List of the Birds of Massachusetts.*—By J. A. Allen.

Twenty-two years have passed since the publication, in 1864, of my first list of the birds of Massachusetts.* In 1870 I added some supplementary notes,† and in 1878 published a new list of the birds of the State,‡ revised to date. In the introduction to this "List" I called attention to the fact that during the previous ten years not less than thirty-four species had been added to the avian fauna of the State. During the eight years which have since elapsed twenty-two species have been added, many captures of other rarities have been recorded, and much has been learned respecting the mode of occurrence of many others, particularly the off-shore aquatic species. Besides this, the nomenclature of the subject has recently been greatly modified, and important changes made in the method of classification. It seems, therefore, desirable to once more bring the subject down to date, where it is my purpose to leave it to other and better hands.

In the introduction to my 1878 "List," I gave a somewhat detailed historical summary of the literature of Massachusetts ornithology, tracing the gradual increase of our knowledge of the subject from the date of Dr. Emmons's "Report," published in 1833, and containing the first formal list of the birds of the State, to the year 1878. During this period the list of Massachusetts birds increased from 160 species to 321. It is not necessary to repeat this summary here; but a few words may be added in respect to the more recent investigations. These relate mainly to the sea-board, and the elevated region about Williamstown, and include observations of great interest on many of the rarer species.

In 1878, in referring to the general subject of Massachusetts ornithology, I mentioned the region west of the Connecticut Valley as still presenting an inviting field for investigation, since it was evident that many species must breed in its more elevated

* Catalogue of the Birds found at Springfield, Mass., with Notes on their Migrations, Habits, etc., together with a List of those Birds found in the State not yet observed at Springfield. Proc. Essex Inst., Vol. IV, No. 2, pp. 48–98, July, 1864.

† Notes on some of the Rarer Birds of Massachusetts. Amer. Nat., Vol. III, pp. 505–519, 568–585, 631–649, Dec. 1869, Jan. and Feb. 1870.

‡ A List of the Birds of Massachusetts, with Annotations. Bull. Essex Inst., Vol. X, 1878, pp. 3–37.

parts which do not commonly pass the summer in the central and eastern portions of the State. "This, in fact," I stated, "is known to be the case with a few, and is inferred for others. What is needed now to complete our knowledge of the ornithology of Massachusetts are exhaustive lists of the birds of at least two localities in Berkshire County—one near its northern boundary and the other near its southern boundary. It is to be hoped that not many years will pass before these desiderata will be supplied."

A part of this interesting field has since been hastily examined by Mr. William Brewster, who spent from June 21 to June 29, 1883, in exploring the region about Williamstown and Graylock Mountain, with results of the highest interest.* The breeding there, previously only inferred, of a number of species was not only confirmed, but four not before known to breed anywhere in the State were found to be common summer residents. Graylock, in short, proved to be, faunally speaking, "a Canadian Island rising from an Alleghanian sea," in which were found breeding many species not known to nest elsewhere in New England south of Maine, New Hampshire, and Vermont. While Mr. Brewster's brief visit to Mount Graylock has added so much to our knowledge of the birds of the western part of the State, Berkshire County, particularly its southwestern portion, still offers an inviting field for ornithological exploration.

In respect to the coast birds, Mr. R. L. Newcomb's notes on the Grallæ,† based on an experience of twenty years' collecting and shooting on the Massachusetts coast, chiefly in Essex County, give valuable and explicit information respecting the relative abundance of the so-called Shore Birds, nearly thirty species of which are briefly mentioned. Mr. William Brewster, in his review of Part II of Stearns and Coues's "New England Bird Life,"‡ also takes occasion to correct many long-standing errors regarding the relative abundance and seasons of occurrence of various species of Ducks, Petrels, and Shearwaters, based on his thorough knowledge of our coast birds. It is to be hoped he will be able

* Notes on the Summer Birds of Berkshire County, Massachusetts. Auk, Vol. I, Jan. 1884, pp. 5–16.

† Notes on Shore Birds. Forest and Stream, Vol. XXII, No. 25, pp. 483, 484, July 17, 1884.

‡ Bull. Nutt. Orn. Club. Vol. VIII, 1883, pp. 161–164.

soon to give us more fully the results of his mature experience with our water birds, respecting which so little is still satisfactorily recorded.

As bearing upon the general subject of Massachusetts ornithology, mention should be made in this connection of Stearns and Coues's handy manual of New England ornithology,* which gives not only the bibliography of the subject (Vol. I, pp. 42–50) to 1879, but detailed references to the records of the rarer species occurring in Massachusetts and the adjoining States. In the compilation of these scattered records the authors give credit for valuable assistance to Mr. H. A. Purdie, of Boston, whose familiarity with the subject, and whose trustworthiness in such matters are well known.

As already stated, twenty-two species of birds have been added to the fauna of the State since the publication of my 1878 "List," including one (*Puffinus borealis* Cory) new to science. The number of species then recorded was 317 (including one given in an "Addendum" and not numbered consecutively in the list), *plus* four extirpated, making a total of 321. The present list numbers 339, *plus* four extirpated, or 443 in all. Of the 24 3
species then given as of probable occurrence, six have been since taken within the limits of the State; six others have been recorded as taken in the Connecticut Valley, within six to ten miles of the southern boundary of Massachusetts.

The present list, as was the former, is divided into five categories, namely: (1) species fully authenticated as birds of the State; (2) species of probable occurrence; (3) extirpated species; (4) doubtful species; (5) introduced species. The classification and nomenclature adopted is that of the new A. O. U. Check List of North American Birds.†

An asterisk (*) prefixed to the current number of a species indicates that it is either known to breed in the State, or that it occurs in summer under circumstances that render its breeding almost unquestionable. A species having its current number in-

* New England Bird Life: being a Manual of New England Ornithology. Revised and edited from the manuscript of Winfrid A. Stearns. By Elliott Coues. Boston: Lee & Shephard. 8vo. Vol. I, 1881, pp. 324. Vol. II, 1883, pp. 409.

† The Code of Nomenclature and Check List of North American Birds, adopted by the American Ornithologists' Union; being the Report of the Committee of the Union on Classification and Nomenclature. New York, 1886. 8vo, pp. viii. +392.

closed in brackets is to be regarded as a casual or accidental visitor only, or so rare as to render it practically an extraneous element of the fauna. The annotations are intended as merely a brief indication of the manner of occurrence of the species, particularly as regards season and relative abundance. The records of capture of the rare or accidental visitors are fully given for the last ten years, and generally for the last twenty years, or for the interval since the publication of my first Catalogue in 1864. The earlier records are generally omitted, but they were included in the 1864 list. These three lists—1864, 1878, and the present—with the "Notes" published in 1870, give a nearly exhaustive record of the occurrences of the rarer birds of the State. As a matter of correlative interest, reference is also made, in most such cases, to records of capture in adjoining States, as tending to indicate the probable status of the species as a Massachusetts bird. With few exceptions only the original record is cited.

I.—SPECIES FULLY AUTHENTICATED AS BIRDS OF THE STATE.

1. Colymbus holbœlli. HOLBŒLL'S GREBE.—Chiefly a winter visitant; not common. Has been taken late in May, in full breeding plumage.

2. Colymbus auritus. HORNED GREBE.—Chiefly a winter visitant; not common. A few remain in summer.

***3. Podilymbus podiceps.** PIED-BILLED GREBE.—Rather rare resident; more common in spring and fall than at other seasons.

***4. Urinator imber.** LOON.—More or less frequent resident in portions of the State, but much more numerous in winter than at other seasons.

5. Urinator lumme. RED-THROATED LOON.—Common winter visitant along the coast; rare in the interior; most numerous in autumn and spring.

6. Fratercula arctica. PUFFIN.—Not uncommon winter visitant along the coast.

[7.]? **Simorhynchus cristatellus.** CRESTED AUKLET.—A small Crested Auk was killed at Chatham, during the winter of

1884–85. The specimen was not preserved, and the record rests wholly on the testimony of an unscientific but intelligent and otherwise trustworthy observer, as recorded in "The Auk" of October, 1885 (II, 388). While the identity of the species cannot therefore be given with certainty, there is very little reason to doubt the determination here made.

8. **Cepphus grylle.** BLACK GUILLEMOT.—Rather common winter visitant, mostly off the coast.

9. **Cepphus mandti.** MANDT'S GUILLEMOT.—Off the coast in winter; not common.

10. **Uria troile.** MURRE.—Rare or irregular winter visitant along the coast. (See *Brewster*, Bull. Nutt. Orn. Club, VII, 1882, 251.)

11. **Uria lomvia.** BRÜNINCH'S MURRE.—Common winter visitant along the coast.

12. **Alca torda.** RAZOR-BILLED AUK.—Not uncommon in winter along the coast.

13. **Alle alle.** DOVEKIE.—Irregular and generally rare winter visitant along the coast; occasionally common. Of accidental occurrence in the interior, having been taken as far from the coast as Springfield.

[14.] **Megalestris skua.** SKUA.—Rare or accidental off the coast. The only record is George's Banks, July, 1878 (*Brewer*, Bull. Nutt. Orn. Club, III, 1878, 188). Mr. William Dutcher informs me that a specimen, now in his cabinet, drifted ashore dead on Long Island, N. Y., in January, 1886; and it may occur sparingly off the whole New England coast.

15. **Stercorarius pomarinus.** POMARINE JAEGER.—A not common spring and autumn visitant along the coast.

16. **Stercorarius parasiticus.** PARASITIC JAEGER.—A regular spring and fall migrant along the coast.

17. **Stercorarius longicaudus.** LONG-TAILED JAEGER.—Rare in spring and fall along the coast.

The three Jaegers have usually been regarded as winter visitors, but fishermen and gunners along the coast say that none of these

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birds are seen by them in the winter, but that they occur along the coast in autumn, and again in the spring.

18. **Rissa tridactyla.** KITTIWAKE.—Common in winter along the coast.

[19.] **Larus glaucus.** GLAUCOUS GULL.—A rare straggler in winter from the north.

20. **Larus leucopterus.** ICELAND GULL.—Rare winter visitor. Recent records are Boston, Jan. 31, 1880 (*Bangs*, Bull. Nutt. Orn. Club, VI, 1881, 124), and November, 1881 (*Cory*, ibid., VII, 1882, 60).

21. **Larus marinus.** GREAT BLACK-BACKED GULL.—Common winter visitant.

[22.] **Larus argentatus.** HERRING GULL.—Rare or casual. I have examined several specimens taken along the coast of Essex County.

22*a*. **Larus argentatus smithsonianus.** AMERICAN HERRING GULL.—Abundant winter visitant; a few remain along the coast in summer, where formerly they probably bred.

23. **Larus delawarensis.** RING-BILLED GULL.—Rather uncommon on the coast in spring and fall. (See *Brewster*, Bull. Nutt. Orn. Club, VIII, 1883, 163.)

*24. **Larus atricilla.** LAUGHING GULL.—Formerly a not uncommon summer visitant; now nearly extirpated from our coast.

25. **Larus philadelphia.** BONAPARTE'S GULL. — Common spring and fall visitant; some remain in winter.

[26.] **Xema sabinii.** SABINE'S GULL.—Accidental. The only Massachusetts record is Boston Harbor, Sept. 27, 1874 (*Brewster*, Am. Sportsman, V, 1875, 370); but it has been taken at Portland and Calais, Maine (*Allen*, Bull. Nutt. Orn. Club, III, 1878, 195).

[27.] **Gelochelidon nilotica.** GULL-BILLED TERN. — Accidental. The only Massachusetts record of this southern species is Ipswich, Sept. 1871 (*Brewster*, Am. Nat., VI, 1872, 306). A specimen, however, has been recorded as taken at Grand Menan, during the latter part of August, 1879 (*Deane*, on authority of G. A. Boardman, Bull. Nutt. Orn. Club, V, 1880, 63).

28. Sterna tschegrava. CASPIAN TERN.—Regular and not rare spring and fall migrant along the coast (*Brewster*, Bull. Nutt. Orn. Club, IV, 1879, 14).

[**29.**] **Sterna maxima.** ROYAL TERN.—Accidental. Two specimens were taken by Messrs. Maynard and Brewster on Nantucket Island, July 1, 1874 (Am. Sports., V, 249, Jan. 16, 1875)—thus far the only authentic record.

[**30.**] **Sterna sandvicensis acuflavida.** CABOT'S TERN.—Accidental. One record only—Chatham, August, 1865 (*Allen*, Am. Nat., III, Feb. 1870, 644).

31. Sterna forsteri. FORSTER'S TERN.—Of rare but probably regular occurrence in autumn along the coast (*Brewster*, Am. Nat., VI., 1872, 306; *Purdie*, ibid., VII, 1873, 693). I saw a number at Chatham in August, 1885.

***32. Sterna hirundo.** COMMON TERN.—Common summer resident along the coast; formerly abundant.

***33. Sterna paradisæa.** ARCTIC TERN.—Common summer resident along the coast; formerly abundant.

***34. Sterna dougalli.** ROSEATE TERN.—Not uncommon along the coast in summer, but much less numerous than formerly.

***35. Sterna antillarum.** LEAST TERN.—Common along the coast in summer.

[**36.**] **Sterna fuliginosa.** SOOTY TERN.—Accidental. There are three recent records of its capture in Massachusetts: Lawrence, Oct. 29, 1876 (*Deane*, Bull. Nutt. Orn. Club, II, 1877, 27); Williamstown, Sept. 1876 (*Tenney*, Am. Nat., XI, 1877, 243); Chatham, Sept. 1877 (*Brewer*, Proc. Bost. Soc. Nat. Hist., XIX, 1878, 308). It has, however, been taken several times in the adjoining States, as follows: Saybrook, Conn., summer of 1876 (*Purdie*, Bull. Nutt. Orn. Club, II, 1877, 22); Granby, Stony Creek, and Faulkner's Island, Conn., autumn of 1876 (*Merriam*, Rev. Birds Conn., 1877, 134, 135); Point Judith, R. I. (*Merriam*, ibid., 134); Parkman, Piscataquis Co., Me., Oct. 5, 1878 (*Deane*, Bull. Nutt. Orn. Club, V, 1880, 64); Rutland, Vt., 1876 (*Brewer*, Proc. Bost. Soc. Nat. Hist., XX, 1880, 276). It will be observed that nearly all of the specimens here mentioned were taken in the

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autumn of 1876, mostly in September, indicating a remarkable invasion of these birds into New England in the fall of that year. Mr. William Dutcher informs me of a specimen taken on Long Island in 1878.

37. Hylochelidon nigra surinamensis. BLACK TERN.—Of somewhat irregular occurrence along the coast in August; sometimes not uncommon, particularly at Nantucket and near Chatham. There are numerous recent records for the New England coast, including that of New Hampshire and Maine as well as Massachusetts. On their occurrence in Massachusetts see *Brewster*, Bull. Nutt. Orn. Club, III, 1878, 190; *Cahoon*, Orn. and Oöl., IX, 1884, 151. I found them in numbers at Chatham in August, 1885, and a large flight is reported as seen there during the first week of September of the same year (*F. B. W*[*ebster*], Orn. and Oöl., X, 1885, 160). See especially notes on this flight by Mr. J. C. Cahoon (Orn. and Oöl., XI, 1866, 10), who reports seeing "as many as several hundred during the day [Aug. 31]; saw one flock of twenty-three sitting on the flats, but did not observe an adult among them."

[38.] Rynchops nigra. BLACK SKIMMER.—Of casual occurrence along the coast, from Long Island to Maine. (See especially *Deane* and *Brewer*, Bull. Nutt. Orn. Club, IV, 1879, 242, 243). Perhaps formerly not uncommon on the coast of Massachusetts (*Purdie*, ibid., VIII, 1882, 125).

[39.] Fulmarus glacialis. FULMAR.—Rare or accidental off the coast. The only record is George's Banks, Nov. 1878 (*Brewer*, Bull. Nutt. Orn. Club, IV, 1879, 64).

40. Puffinus borealis. CORY'S SHEARWATER.—Off the coast, at times apparently not uncommon. There are thus far, however, but two records—off Chatham Island, Cape Cod, Oct. 11, 1880 (*Cory*, Bull. Nutt. Orn. Club, VI, 1881, 84, where the species was first described), and again taken near the same place, August 2, 1883 (*Job*, ibid., VIII, 1883, 244). A considerable number of specimens were obtained by Mr. Cory and many others were seen; Mr. Job secured three.

41. Puffinus major. GREATER SHEARWATER.—Abundant off the coast in summer.

42. Puffinus stricklandi. SOOTY SHEARWATER.—Abundant off the coast in summer.

This and the preceding species have hitherto usually been regarded as winter visitors, but intelligent fishermen and gunners assure me that no species of Shearwater is seen by them off the Massachusetts coast in winter.

43. Oceanodroma leucorhoa. LEACH'S PETREL.—Common summer visitant along the coast. Breeds on the coast of Maine.

44. Oceanites oceanicus. WILSON'S PETREL.—Common off the coast in summer.

[45.] Pelagodroma marina. WHITE-FACED PETREL.—Accidental. The only record is off the coast, Sept. 2, 1885 (*Ridgway*, Auk, II, 1885, 386).

[46.] Sula sula. BOOBY.—Rare or accidental. Thus far there is only one recent record—Cape Cod, Sept. 17, 1878 (*Brewer*, Bull. Nutt. Orn. Club, IV, 1879, 191). But there is an earlier and perhaps doubtful record, namely, Essex County, "September, rare" (*Putnam*, Proc. Essex Inst., I, 1856, 221).

47. Sula bassana. GANNET.—A not uncommon migrant in early spring and late fall. Not a winter visitant, as usually stated, according to the testimony of fishermen and gunners.

48. Phalacrocorax carbo. CORMORANT.—Rare in spring and fall, and probably rare in winter. (See *Brewster*, Auk, II, 112.) Winters from the coast of Maine northward, straggling at the same season southward to New Jersey, and even South Carolina. Is supposed to have formerly bred from Massachusetts northward. A recent Rhode Island record, of interest in this connection, is Newport, March 27 and April 10, 1884 (*Jencks*, Random Notes on Nat. Hist., II, 1885, 34).

49. Phalacrocorax dilophus. DOUBLE-CRESTED CORMORANT. —Common spring and fall migrant.

[50.] Pelecanus erythrorhynchos. AMERICAN WHITE PELICAN. — Now accidental; formerly common (*Allen*, Bull. Nutt. Orn. Club, I, 1876, 60). The only recent correct record of its capture appears to be North Scituate, Oct. 6, 1876 (*Purdie*, Bull. 1886.]

Nutt. Orn. Club, II, 1877, 22). The specimens reported by me (Am. Nat., III, 1870, 640) as taken at Ipswich and Nantucket were found later to be *P. fuscus.* (See remarks under *P. fuscus.*) There is, however, a recent New Brunswick record (*Chamberlaine*, Bull. Nutt. Orn. Club, VII, 1882, 106).

[51.] **Pelecanus fuscus.** BROWN PELICAN.—Accidental. Ipswich (*Maynard*, Nat. Guide, 1870, 149); Nantucket (*Allen*, Am. Nat., III, Feb. 1870, 640), but wrongly given as *P. erythrorhyncos.**

52. **Merganser americanus.** AMERICAN MERGANSER.—Common winter visitant, but most numerous in fall and spring. Probably formerly bred in the State.

53. **Merganser serrator.** RED-BREASTED MERGANSER.—Common in spring and fall, many remaining in winter.

54. **Lophodytes cucullatus.** HOODED MERGANSER.—Rather common spring and autumn visitant, many remaining in winter, and a few perhaps in summer.

*55. **Anas boschas.** MALLARD.—A very rare straggler in spring and fall. Said to breed regularly at Somerset (*Coues* and *Slade*, Bull. Nutt. Orn. Club, VIII, 1883, 186).

*56. **Anas obscura.** BLACK DUCK.—Abundant winter resident, and rare in summer; doubtless formerly regularly resident the whole year. A recent record of its breeding in the State is Rehoboth (*F. H. C*[*arpenter*], Orn. and Oöl., IX, 1884, 125).

57. **Anas strepera.** GADWALL.—Rare spring and autumn visitant; perhaps only accidental. (See *Brewster*, Bull. Nutt. Orn. Club, VIII, 1883, 163.)

58. **Anas americana.** BALDPATE.—Spring and autumn visitant. Rare.

59. **Anas carolinensis.** GREEN-WINGED TEAL.—Rather uncommon spring and autumn migrant (*Brewster*, Bull. Nutt. Orn. Club, VIII, 1878, 163).

60. **Anas discors.** BLUE-WINGED TEAL.—Rather rare spring, and abundant autumn, migrant; formerly doubtless a summer resident. (See *Brewster*, Bull. Nutt. Orn. Club, VIII, 1883, 163.)

* Corrected in a note added to last page of author's extras, in which it is stated that "from information just received there is every reason for believing that this flock [of White Pelicans, mentioned on page 40 (of extras) as having visited Nantucket Island,] were Brown Pelicans."

[*July*,

61. Spatula clypeata. SHOVELLER.—Rare spring and autumn visitant. It was formerly, judging from its present breeding range in the interior, a frequent summer resident. (Cf. *Brown*, on its occurrence at Portland, Maine, Bull. Nutt. Orn. Club, VI, 1881, 187.)

62. Dafila acuta. PINTAIL. "Gray Duck" of gunners.—Rare winter visitant.

***63. Aix sponsa.** WOOD DUCK.—Common summer resident.

64. Aythya americana. REDHEAD.—Rare spring and autumn migrant.

65. Aythya vallisneria. CANVAS-BACK.—Very rare spring and autumn visitant.

66. Aythya marila nearctica. AMERICAN SCAUP DUCK.—Not common spring and autumn visitant, some remaining in winter.

67. Aythya affinis. LESSER SCAUP DUCK.—Spring and fall migrant; not common.

68. Aythya collaris. RING-NECKED DUCK.—Rare spring and autumn migrant.

69. Glaucionetta clangula americana. AMERICAN GOLDEN-EYE.—Common winter resident.

70. Glaucionetta islandica. BARROW'S GOLDEN-EYE.—Rare winter visitant. Only recently added to the fauna of the State on record of its actual capture (*Brewster*, Am. Nat., VI, May, 1872, 306). There is also a Connecticut record (*Merriam*, Rev. Bds. Conn., 1877, 126).

71. Charitonetta albeola. BUTTERBALL.—Common winter visitant.

72. Clangula hyemalis. OLD SQUAW. — Common winter visitant.

73. Histrionicus histrionicus. HARLEQUIN DUCK.—Rare winter visitant. Formerly, like most of the Ducks, more common than now (*Brewer*, Bull. Nutt. Orn. Club, II, 1877, 46). Still common in winter on the coast of Maine (*Brewster*, ibid., VIII, 1883, 163).

[74.] **Camptolæmus labradorius.**—Labrador Duck.—Formerly a not uncommon winter visitant; no recent record of its capture in this State. "Abundant" in Boston market fifty years ago (*Brewer*, Bull. Nutt. Orn. Club, II, 1877, 46). The specimens figured by Audubon were killed by the "Honourable Daniel Webster of Boston.....on the Vineyard Islands." The latest record of its capture anywhere is Elmira, Chemung County, N. Y., Dec. 12, 1878 (*Gregg*, Am. Nat., XIII, 1879, 128).

[75.] **Somateria mollissima.** Eider.—Doubtless a rare winter straggler from the north. (See *Brewster*, Auk, II, 1885, 111.)

76. **Somateria dresseri.** American Eider.—Not uncommon in spring and fall, some remaining in winter.

77. **Somateria spectabilis.** King Eider.—Rare winter visitant.

78. **Oidemia americana.** American Scoter.—Common in spring and fall, and not rare in winter.

79. **Oidemia deglandi.** White-winged Scoter.—Common winter visitant. More common than the last or next.

80. **Oidemia perspicillata.** Surf Scoter.—Common winter visitant.

81. **Erismatura rubida.** Ruddy Duck.—Rather common winter visitant, but most numerous in fall and spring.

[82.] **Chen hyperborea.** Lesser Snow Goose.—Rare or accidental winter visitor. Several specimens have come to my knowledge, taken in Massachusetts, which seem referable to this form.

82*a*. **Chen hyperborea nivalis.** Greater Snow Goose.—Rare winter visitant.

83. **Anser albifrons gambeli.** American White-fronted Goose.—Rare spring and fall migrant. Some years since I found specimens in the Boston markets I had reason to believe were killed in this State. Dr. Brewer says it was more common forty to fifty years ago than now, as was the case with many of our other Ducks and Geese (Bull. Nutt. Orn. Club, II, 1877, 46).

84. **Branta canadensis.** Canada Goose.—Common spring and autumn visitant; probably formerly a summer resident.

84*a*. **Branta canadensis hutchinsi.** HUTCHIN'S GOOSE.—Rather irregular rare spring and autumn visitant, but more common formerly. (See *Brewer*, Bull. Nutt. Orn. Club, II, 1877, 46; *Brewster*, ibid., VIII, 1883, 163.)

85. **Branta bernicla.** BRANT.—Not uncommon spring and autumn migrant.

[86.] **Branta leucopsis.** BARNACLE GOOSE.—Accidental. The only Massachusetts record is North Chatham, Nov. 1, 1885 (*F. H. C[arpenter]*, Orn. and Oöl., XI, 1886, 16). The specimen was mounted by Mr. N. Vickary of Lynn, who also informed me of its capture in a letter.

There are numerous extralimital records for eastern North America, it having been taken in Southern Labrador, Maine, Vermont, on Long Island, and in North Carolina.

87. **Branta nigricans.** BLACK BRANT.—Rare or accidental, with the preceding. Though commonly attributed to the State there are thus far few positive records of its capture here. (See *Brewer*, Proc. Boston Soc. Nat. Hist., XVII, 1875, 447; *Cory*, Auk, I, 1884, 96.)

[88.] **Olor columbianus.** WHISTLING SWAN.—In early times (first half of the seventeenth century) this species was not uncommon (see *Allen*, Bull. Nutt. Orn. Club, I, 1876, 58), but at present it can be regarded only as a rare and irregular, perhaps accidental, visitor. Recent authentic records are Nantucket, March 4, 1878 (*Brewster*, Bull. Nutt. Orn. Club, III, 1878, 198); Nahant, about 1865 (*Brewer*, Proc. Bost. Soc. Nat. Hist., XX, 1879, 274); Somerset, Oct. 16, 1880 (*Slade*, Bull. Nutt. Orn. Club, VI, 1881, 123). There are also recent records for New Hampshire (Seabrook, *Brewster*, Bull. Nutt. Orn. Club, IV, 1879, 125), Connecticut (Branford Harbor, *Merriam*, Rev. Bds. Conn., 1877, 120), and Rhode Island (*Dexter*, Forest and Stream, XIII, 1879, 848). Also St. John, N. B. (*Gilbert*, Canad. Nat. and Sportsman, II, 1882, 144).

[89.] **Plegadis autumnalis.** GLOSSY IBIS.—Accidental. Several early records of its occurrence, but only three recent ones: Nantucket, Sept. 1869 (*Allen*, Am. Nat., III, 1870, 637); Cape Cod (Orleans and Chatham), three specimens, about May 5, 1878

(*Brewer*, Bull. Nutt. Orn. Club, III, 1878, 151; *Cory* and *Allen*, ibid., 152). A detailed history of the occurrence of this bird in Massachusetts and neighboring parts of New England is given in Stearns and Coues's "New England Bird Life" (II, 1883, 254–257).

[90.] **Tantalus loculator.** Wood Ibis.—Accidental. Recorded by me (Bull. Nutt. Orn. Club, VIII, 1883, 187), on what has proved to be doubtful authority, as taken at Georgetown, June 19, 1880. The authenticity of the alleged capture has since been investigated with care, without eliciting any evidence tending to impeach the record, beyond the fact of the untrustworthy character of my informant (see Auk, I, 1884, 295–297). The capture of the species at Glasco, Ulster County, N. Y., July 8, 1884 (*Fisher*, Auk II, 1885, 221), not far from the western border of the State, and also at Troy, N. Y., at Williamsport, Penn. (*Allen*, Bull. Nutt. Orn. Club, I, 1876, 96), Elizabethtown, Lancaster Co., Penn. (*Sherratt*, Orn. and Oöl., IX, 1884, 115), and in West Virginia (*Wall*, American Field, XXII, 1884, 82), shows that the species occasionally wanders far beyond its usual range, and thus gives probability of its occurrence in Massachusetts.

*91. **Botaurus lentiginosus.** American Bittern.—Common summer resident.

*92. **Botaurus exilis.** Least Bittern.—Not generally common, but rather frequent at some localities.

*93. **Ardea herodias.** Great Blue Heron.—A not common summer resident.

[94.] **Ardea egretta.** American Egret.—Accidental. Several comparatively recent instances of its capture have been recorded (Hudson, Ashland, and Lynn, *Allen*, Am. Nat., III, 1870, 637; Westford, 1873, *Purdie*, Am. Nat., VII, 693). Also Saybrook, Conn., Aug. 11, 1881 (*Sage*, O. & O., VII, 189, and ibid., VIII, 4). —It has been taken also in New Brunswick (Grand Menan), Nov. 3, 1878), and Halifax, Nova Scotia (*Deane*, Bull. Nutt. Orn. Club, IV, 1879, 63). For references to earlier records of this and the two following species see Stearns and Coues's "New England Bird Life," Vol. II, 1883, 260–264.

[95.] **Ardea candidissima.** Snowy Heron.—Accidental. There are fewer recorded instances of the occurrence of this species than of the preceding. A recent one is Nantucket, March, 1882 (*Purdie*, Bull. Nutt. Orn. Club, VII, 1882, 251).

[96.] **Ardea cærulea.** Little Blue Heron.—Accidental. While there is no recent record of its capture in Massachusetts, it may be of interest to note the following: Scarborough, Maine (*Brown*, Bull. Nutt. Orn. Club, VII, 1882, 123); Saybrook, Conn. (*Clark*, Orn. & Oöl., VII, 1882, 51); Warwick, R. I., July 13, 1878 (*Deane*, Bull. Nutt. Orn. Club, V, 1880, 123).

*97. **Ardea virescens.** Green Heron.—Common summer resident.

*98. **Nycticorax nycticorax nævius.** Black-crowned Night Heron.—Common summer resident. Stragglers have been observed at Cambridge in winter.

[99.] **Nycticorax violaceus.** Yellow-crowned Night Heron.—Accidental. Two records: Lynn, Oct. 1862 (*Allen*, Am. Nat., III, 1870, 637); Somerville, July 30, 1878 (*Brewster*, Bull. Nutt. Orn. Club, IV, 1879, 124).

[100.] **Rallus elegans.** King Rail.—Rare or accidental. Nahant, Nov. 21, 1875 (*Purdie*, Bull. Nutt. Orn. Club, II, 1877, 22); Sudbury Meadows, "some years since" (*Purdie*, ibid., III, 1878, 146). A rare summer resident in Southern Connecticut (*Merriam*, Rev. Bds. Conn., 115).

[101.] **Rallus longirostris crepitans.** Clapper Rail.—Rare or accidental. Boston Harbor, May 4, 1875 (*Purdie*, Bull. Nutt. Orn. Club, II, 1877, 22); Plymouth, Oct. 1879 (*Purdie*, ibid., VI, 1881, 62). It has also occurred near Portland, Maine (*Brown*, ibid., IV, 1879, 108), and has been repeatedly taken in Connecticut (*Merriam*, Rev. Bds. Conn., 1877, 115).

*102. **Rallus virginianus.** Virginia Rail.—Common summer resident.

*103. **Porzana carolina.** Sora.—Common summer resident.

104. **Porzana noveboracensis.** Yellow Rail.—Rare summer visitant, but occasionally common at some localities, as at Plymouth (*Brewster*, Bull. Nutt. Orn. Club, VI, 1881, 186). Has

also been recorded from Maine and New Brunswick, as well as Connecticut.

***105. Porzana jamaicensis.** BLACK RAIL.—Very rare, perhaps accidental, summer visitant. One instance only of its capture in Massachusetts hitherto recorded (Clark's Isl., Plymouth Harbor, Aug. 1869, *Purdie*, Bull. Nutt. Orn. Club, II, 1877, 22). As yet only two records of its capture in Connecticut, where it has been found breeding (see *Merriam*, Rev. Bds. Conn., 1877, 119).

I now add another Massachusetts record, on information furnished me by Mr. A. W. Baker, who found a pair at Chatham with young in July, 1884, and a nest with four eggs in May, 1885.

[106.] Ionornis martinica. PURPLE GALLINULE.—Accidental. A recent record of its occurrence is Rockport, April 12, 1875 (*Whitman*, Am. Nat., IX, 1875, 674). More easterly recent records are Calais, Me. (*Boardman*, Am. Nat., III, 498); Boothbay, Me. (*Purdie*, Bull. Nutt. Orn. Club, V, 1880, 242); Halifax, Jan. 30, 1870 (*Jones*, Am. Nat., IV, 253); New Brunswick, two instances (*Brewster*, Bull. Nutt. Orn. Club, VI, 1881, 186; *Chamberlaine*, ibid., VII, 1882, 105). A new Rhode Island record is Westerly, about 1857 (*Jencks*, ibid., VII, 1881, 124). (For references to earlier records see Stearns and Coues's "New England Bird Life," II, 1883, 293.)

***107. Gallinula galeata.** FLORIDA GALLINULE.—Rare summer visitant, doubtless occasionally breeding (see *Allen*, Am. Nat., III, Feb. 1870, 639). Recent records are Nantucket, Oct. 1872 (*Brewer*, Bull. Nutt. Orn. Club, IV, 1879, 63), and Wayland, Sept. 10, 1878 (*Brewer*, Proc. Bost. Soc. Nat. Hist., XX, 273). A recent New Brunswick record is Dick's Lake, Sept. 1880 (*Brewster*, Bull. Nutt. Orn. Club, VI, 1881, 186). Given as rather common in Connecticut by Merriam (Rev. Bds. Conn., 1877, 19).

***108. Fulica americana.** AMERICAN COOT.—Rare summer resident; more numerous in fall and spring.

109. Crymophilus fulicarius. RED PHALAROPE. — Not common spring and autumn migrant, chiefly off the coast. Rarely taken. "Well out in Massachusetts Bay," Aug. 31, 1878 (*Newcomb*, Bull. Nutt. Orn. Club, IV, 1879, 127; Forest and Stream, XXII, No. 25, July 17, 1884, 484).

110. Phalaropus lobatus. NORTHERN PHALAROPE.—Spring and fall migrant, chiefly off the coast. Mr. Brewster mentions it as "of by no means rare occurrence in Boston market, from Cape Cod and elsewhere along the Massachusetts coast.... It is, however, like several other off-coast species, not commonly found near the land unless forced to take shelter from severe storms" (Bull. Nutt. Orn. Club, III, 1878, 152). Swampscott (*Newcomb*, Forest and Stream, XXII, No. 25, July 17, 1884, 484). A recent inland record is Ware, Oct. 13, 1875 (*Stearns*, Bull. Nutt. Orn. Club, V, 1880, 122).

111. Steganopus tricolor. WILSON'S PHALAROPE. — Very rare. No recent nor very explicit Massachusetts records. Doubtless not uncommon in migrations off the coast. Taken at Newport, R. I., Aug. 2, 1880 (*Jencks*, Bull. Nutt. Orn. Club, V, 1880, 237). There are several recent Long Island records.

[112.] Recurvirostra americana. AMERICAN AVOCET.—Accidental. Natick, Oct. 19, 1880 (*Purdie*, Bull. Nutt. Orn. Club, VI, 1881, 123). Interesting extralimital records are near Saybrook, Conn. (*Merriam*, Rev. Bds. Conn., 1877, 103); Point Lepreaux, N. B., 1862 (cf. *Brewer*, Proc. Bost. Soc. Nat. Hist., XVII, 1875, 452); Quaco, N. B., 1880, three specimens (*Boardman*, Bull. Nutt. Orn. Club, V, 1880, 241), and St. Martins, N. B. (*Chamberlaine*, ibid., VII, 1882, 105). At the latter place one or more of these birds reported as taken each year for the five preceding years, two usually being met with together.

[113.] Himantopus mexicanus. BLACK-NECKED STILT.—Accidental. Mr. Maynard gives it, on the authority of gunners and others, "as occasionally seen along the sandy beaches" (Nat. Guide, 1870, 143). Mr. Boardman saw, some years since, two specimens in a Boston market, which he was assured were taken in this State (*Allen*, Am. Nat., III, 1870, 638). It has been taken at Calais, Maine (*Boardman*, Proc. Bost. Soc. Nat. Hist., IX, 1862, 128), and in New Brunswick (*Chamberlaine*, Bull. Nutt. Orn. Club, VII, 1882, 105), where several had been taken at Mace's Bay during former years.

***114. Philohela minor.** AMERICAN WOODCOCK.—Common summer resident.

***115. Gallinago delicata.** Wilson's Snipe.—Common during migrations, and a rather rare summer resident. A few pass the winter at favorable localities.

116. Macrorhamphus griseus. Dowicher.—Rather common spring and autumn migrant.

117. Macrorhamphus scolopaceus. Long-billed Dowicher.—Not infrequent spring and fall migrant. (This, in my 1878 "List," was combined with the preceding.)

118. Micropalama himantopus. Stilt Sandpiper. — Not common, and occurring chiefly during the autumnal migration. For the history of this bird's mode of occurrence and distribution in Massachusetts, and along the New England coast generally, see Stearns and Coues's "New England Bird Life" (II, 1883, 206-212), and the references there given.

119. Tringa canutus. Knot.—Common spring and autumn visitant.

120. Tringa maritima. Purple Sandpiper.—Not uncommon in winter along rocky shores.

121. Tringa maculata. Pectoral Sandpiper.—Rare during its spring migrations, but common "from July 10 or 15 until quite late in the fall" (*Newcomb*, Forest and Stream, XXII, No. 25, July 17, 1883, 483).

122. Tringa fuscicollis. White-rumped Sandpiper.—Common spring and fall migrant.

[123.] Tringa bairdi. Baird's Sandpiper.—Rare or casual. The records are Long Island, Boston Harbor, Aug. 27, 1870 (*Brewster*, Am. Nat., VI, 1872, 306); Swampscott, Aug. 27, 1876 (*Brewer*, Bull. Nutt. Orn. Club, III, 1878, 140); Marblehead, Aug. 15, 1881 (*Lamb*, Journ. Bost. Zoöl. Soc., I, 1882, 37). There are also records for New Hampshire, Maine, and Long Island, N. Y.

124. Tringa minutilla. Least Sandpiper.—Abundant during its migrations.

125. Tringa alpina pacifica. Red-backed Sandpiper.—Rare spring and common autumn visitant; a few sometimes remain in summer.

[126.] **Tringa ferruginea.** CURLEW SANDPIPER.—Rare or accidental in spring and fall. According to Dr. Brewer, there was no authenticated instance of its occurrence in New England on record prior to 1875, when he announced the capture of a specimen "recently taken" in Ipswich (Proc. Bost. Soc. Nat. Hist., XVII, 1875, 446). Mr. E. A. Samuels, however, refers to its having been shot on Cape Ann in 1865 (Orn. and Oöl., New Eng., 1868, 447). Mr. Brewster has since recorded its capture in East Boston, early in May, 1866 (Bull. Nutt. Orn. Club, I, 1876, 51). Mr. Deane has added Cape Cod, May 10, 1878, and Nahant (ibid., IV, 1879, 124). It has also been taken at Scarborough, Me., Sept. 15, 1881 (*Purdie*, ibid., VII, 1882, 124), and there are several Connecticut records.

127. **Ereunetes pusillus.** SEMIPALMATED SANDPIPER.—Abundant during its migrations; a few sometimes met with in summer.

[128.] **Ereunetes occidentalis.** WESTERN SANDPIPER.—Doubtless of casual occurrence merely. Long Island, Boston Harbor, Aug. 27, 1870 (*Henshaw*, Auk, II, 1885, 384). Has recently been found in numbers on the coast of Maryland and Virginia (*Beckham*, ibid., II, 1885, 110; *Smith*, ibid., II, 1885, 285).

129. **Calidris arenaria.** SANDERLING.—Abundant spring and autumn migrant; stragglers sometimes remain in summer.

130. **Limosa fedoa.** MARBLED GODWIT.—Rare spring and autumn visitant. Ipswich, July 17, 1869 (*Maynard*, Nat. Guide, 1870, 142). Dr. Brewer says "A few are seen both in their spring migrations and in the fall, in the more easterly portions of Barnstable County" (Water Birds of North America, I, 1884, 257).

131. **Limosa hæmastica.** HUDSONIAN GODWIT.—Of rare or irregular occurrence, chiefly in the fall; sometimes not uncommon.

132. **Totanus melanoleucus.** GREATER YELLOW-LEGS.—Common spring and autumn migrant, and a few linger in summer.

133. **Totanus flavipes.** YELLOW-LEGS.—Occasional spring and common autumn visitant; rare in summer.

134. Totanus solitarius. SOLITARY SANDPIPER.—Common in spring and fall; stragglers sometimes remain in summer. Has been found breeding at Rutland, Vt., by Mr. Jenness Richardson (*Brewer*, Bull. Nutt. Orn. Club, III, 1878, 197).

***135. Symphemia semipalmata.** WILLET.—Rare summer resident, sometimes breeding. More common in spring and fall. Dr. Brewer says he "met with it breeding on the small Island of Muskeget, near Nantucket (Water Birds of North America, I, 1884, 287).

[136.] Pavoncella pugnax. RUFF.—The only Massachusetts records of its occurrence appear to be Newburyport marshes, May 28, 1871 (*Brewster*, Am. Nat., VI, 1872, 306), and Chatham, Sept. 11, 1880 (*Plummer*, Forest and Stream, Oct. 7, 1880, 186). Extralimital records include Long Island (several instances), Calais, Maine, several instances (*Boardman*, Proc. Bost. Soc. Nat. Hist., IX, 1862, 129), Upton, Maine (*Brewster*, Bull. Nutt. Orn. Club, I, 1876, 19), and in the interior as far west as Western Ontario (*Morden* and *Saunders*, Canad. Sportsm. and Nat., III, 1883, 243) and Ohio (*Wheaton*, Bull. Nutt. Orn. Club, II, 1877, 83).

***137. Bartramia longicauda.** BARTRAMIAN SANDPIPER.—Not very common summer resident; abundant during migrations.

138. Tryngites subruficollis. BUFF-BREASTED SANDPIPER.—Rather uncommon spring and autumn visitant.

***139. Actitis macularia.** SPOTTED SANDPIPER.—Common summer resident.

140. Numenius longirostris. LONG-BILLED CURLEW.—A not very common spring and autumn visitant.

141. Numenius hudsonicus. HUDSONIAN CURLEW.—Spring and fall migrant; sometimes quite numerous, and generally more common than either of the other species of this genus.

142. Numenius borealis. ESKIMO CURLEW.—Rather uncommon spring and autumn migrant.

143. Charadrius squatarola. BLACK-BELLIED PLOVER.—Generally more or less common during spring and fall.

144. Charadrius dominicus. AMERICAN GOLDEN PLOVER.—Common autumn migrant; very rare in spring (see *Brewster*, Bull. Nutt. Orn. Club, VIII, 1883, 163.)

*145. **Ægialitis vocifera.** KILLDEER.—A not common summer resident.

146. **Ægialitis semipalmata.** SEMIPALMATED PLOVER.—Abundant spring and autum visitant.

*147. **Ægialitis meloda.** PIPING PLOVER.—Common summer resident along the coast.

[147*a*.] **Ægialitis meloda circumcincta.** BELTED PIPING PLOVER.—Probably of rare or casual occurrence, it having been taken on Long Island (Rockaway, April 30, 1873, *Eagle*, Bull. Nutt. Orn. Club, III, 1878, 94), and at the Magdalen Islands, Gulf of St. Lawrence (*Cory*, Naturalist in the Magdalen Islands, 1878, 61). I am under the impression that I have seen a Massachusetts example.

[148.] **Ægialitis wilsonia.** WILSON'S PLOVER.—Accidental. Gurnet ("Conn."=Mass.), Aug. 20, 1877 (*Coues*, apud *Fisk*, Bull. Nutt. Orn. Club, VII, 1882, 59). There are several recent Long Island (N. Y.) records, and it has lately been taken in Nova Scotia (*Goss*, Auk, II, 221).

149. **Arenaria interpres.** TURNSTONE.—Rather common spring and autumn visitant.

[150.] **Hæmatopus palliatus.** AMERICAN OYSTER-CATCHER.—Now of merely accidental occurrence. The only recent explicit record is Chatham, April, 1885 (*Brewster*, Auk, II, 1885, 384; *Cahoon*, same specimen, Orn. and Oöl., X, 1885, 160). Formerly, doubtless, not uncommon.

151. **Colinus virginianus.** BOB-WHITE.—More or less common resident in most parts of the State.

[152.] **Dendragapus canadensis.** CANADA GROUSE.—Accidental. Only two recorded instances of its capture, which are Gloucester, 1851 (*Putnam*, Proc. Essex Inst., I, 1856, 224); Roxbury, about 1865 (*Allen*, Am. Nat., III, 1870, 636).

*153. **Bonasa umbellus.** RUFFED GROUSE.—Common resident.

*154. **Tympanuchus cupido.** PRAIRIE HEN.—Formerly common in various parts of the State, but long since extirpated, except on the Island of Martha's Vineyard, where they still exist in considerable numbers. (See *Brewster*, Auk II, 1885, 80–84.) Western birds have at different times been turned out in Barnstable and Berkshire Counties, where some, or their descendants, still survive. (See beyond, under "4. Introduced species.")

***155.** **Ectopistes migratorius.** PASSENGER PIGEON.—Irregular summer resident, not generally common. Has greatly decreased in numbers during the last twenty to fifty years.

***156. Zenaidura macroura.** MOURNING DOVE.—Common summer resident.

[157.] Cathartes aura. TURKEY VULTURE.—Accidental. Two were taken in the State in 1863 (*Samuels*, Agr. Mass., Secy's Rep. 1863, App., p. xviii). Seen in Waltham, August, 1867 (*Maynard*, Nat. Guide, 1870, 137*).

There are numerous Connecticut records (see *Merriam*, Rev. Bds. Conn. 1877, 91; *Sage*, Orn. and Oöl., VII, 141), and it has been recorded from Hampton Falls, N. H. (*Cory*, Bull. Nutt. Orn. Club, VII, 1882, 184). Maine records are Calais (*Verrill*, Proc. Bost. Soc. Nat. Hist., IX., 1862, 122), Standish, Cumberland County (*Smith*, Forest and Stream, XX, No. 2, Feb. 8, 1883, 26), Freyburg, (*Gushee*, ibid., XX, 1883, 245), Buxton (*Brown*, Proc. Portland Soc. Nat. Hist., 1882), and Grand Menan (*Moses*, Forest and Stream, V, No. 3, Aug. 26, 1875).

[158.] Catharista atrata. BLACK VULTURE.—Accidental. Swampscott, November, 1850 (*Putnam*, Proc. Essex Inst., I, 1856, 223); Gloucester, Sept. 28, 1863 (*Allen*, ibid., IV., 1864, 81); Hudson (*Allen*, Am. Nat., III, 1870, 646). Maine records are Calais (*Boardman*, Am. Nat., III, 1869, 498), and Campobello Island, August, 1879 (*Deane*, Bull. Nutt. Orn. Club, V, 1880, 63). A Vermont record is Woodbury, July, 1884 (*Graham*, Random Notes on Nat. Hist., I, 1884, No. 9, 4).

[159.] Elanoides forficatus. SWALLOW-TAILED KITE.—Accidental. Seen at Whately, about 1868 (*Allen*, Am. Nat., III, 1870, 645); taken at West Newberry, Sept. 1882 (*Coues*, apud *Newcomb*, Bull. Nutt. Orn. Club, VIII, 1883, 61). Dr. Merriam

* Dr. Coues says at the end of his account of this species in "New England Bird Life" (II, 1883, 137), "and Mr. Purdie's manuscript makes us aware of two later Massachusetts instances." Mr. Purdie writes me that "Massachusetts" should read "Maine," Dr. Coues having misunderstood his note. These two Maine cases are on the authority of Mr. Boardman, and appear to have not yet been published.

gives it as "a rare straggler from the south" in Connecticut (Rev. Bds. Conn., 1877, 76), and there are Long Island records for 1837 (*Giraud*, Birds of Long Island, 1844, 13) and 1845 (*Berier*, Bull. Nutt. Orn. Club, VI, 1881, 126). (An erroneous record for Maine is given in "Forest and Stream," XXI, 1884, No. 19, 563; corrected, *l. c.*, No. 24, 464.)

***160. Circus hudsonius.** MARSH HAWK.—Common summer resident.

***161. Accipiter velox.** SHARP-SHINNED HAWK.—Rather common summer resident. Has also been taken in winter (*F. H. C[arpenter]*, Orn. and Oöl., XI, 1886, 25; *Allen*, Auk, II, 311).

***162. Accipiter cooperi.** COOPER'S HAWK.—Common summer resident; of occasional occurrence in winter.

163. Accipiter atricapillus. AMERICAN GOSHAWK.—Rather frequent winter visitant. Has been seen in summer, and perhaps occasionally breeds in the western part of the State.

***164. Buteo borealis.** RED-TAILED HAWK.—A rather common resident, but most numerous in fall and spring.

***165. Buteo lineatus.** RED-SHOULDERED HAWK.—Common resident; most abundant in fall and spring.

[166.] Buteo swainsoni. SWAINSON'S HAWK.—Accidental. Only two instances of its capture thus far recorded—Salem, winter of 1871–72 (*Allen*, Bull. Essex Inst., X, 1878, 22); Wayland, Sept. 12, 1876 (*Brewster*, Bull. Nutt. Orn. Club, III, 1878, 39).

***167. Buteo latissimus.** BROAD-WINGED HAWK.—Rather rare summer resident.

168. Archibuteo lagopus sancti-johannis. AMERICAN ROUGH-LEGGED HAWK.—Rather common winter visitant, but of somewhat local distribution.

***169. Aquila chrysaëtos.** GOLDEN EAGLE.—Very rare winter visitant. Recent records of its capture are Munson, Nov. 1864; Deerfield, Dec. 14, 1865; Westfield, three specimens, 1866 (*Allen*, Am. Nat., III, Dec. 1869); Fairhaven, Nov. 21, 1873 (*Allen*, Bull. Essex Inst., X, 1878, 22). This specimen was sent in the flesh by Captain Charles Bryant to the Museum of Comparative Zoölogy, where it is now preserved. Also Williamstown, 1886.]

and said to breed on Graylock (*Brewster*, Auk, I, 1884, 10). Mr. E. H. Forbush informs me of a specimen taken in Paxton, Worcester County, October 22, 1884.

***170. Haliæetus leucocephalus.** BALD EAGLE.—Rare resident.

[171.] Falco rusticolus. GRAY GYRFALCON.—Of rare or accidental occurrence in winter. There are various records.

[171*a*.] Falco rusticolus obsoletus. BLACK GRYFALCON.—Casual or accidental. Breed's Island, Boston Harbor, Oct. 1876 (*Cory*, Bull. Nutt. Orn. Club, II, 1877, 27); Essex County (*Purdie*, Bull. Nutt. Orn. Club, IV, 1879, 189); Stowe, 1881 (*Brewster*, ibid., VIII, 1883, 184). There are also Vermont, Maine, Rhode Island and Long Island records. (For New England records of Gryfalcons see *Purdie*, in Stearns and Coues's "New England Bird Life," II, 1883, 110, 111; *Jencks*, Auk, I, 1884, 94.)

***172. Falco peregrinus anatum.** DUCK HAWK.—Rare resident; more common in winter than in summer, and along the coast than in the interior. Mount Tom and Sugar Loaf Mountain are well known as among its breeding places, and it doubtless breeds elsewhere in the western part of the State, as it does at various localities in Connecticut and in the Helderberg Mountains near Albany, N. Y. (*Lintner*, Auk, I, 1884, 391).

173. Falco columbarius. PIGEON HAWK.—Rather rare, occurring chiefly in spring, fall, and winter.

174. Falco sparverius. AMERICAN SPARROW HAWK.—More or less common resident; most numerous, however, in spring and fall.

175. Pandion haliaëtus carolinensis. AMERICAN OSPREY.—Occasional summer visitant. Formerly bred in the State, but now nests here very rarely. Mr. F. H. C[arpenter] refers to a colony of "about forty nests" on Palmer River, near Rehoboth (Orn. and Oöl., IX, 1884, 100).

[176.] Strix pratincola. AMERICAN BARN OWL.—Very rare or accidental. Only two specimens as yet known to have been taken in the State—one at Springfield, May, 1868 (*Allen*, Proc. Essex Inst., VI, 1868, 312); the other at Lynn, in 1865 (*Allen*, Am. Nat., III, 1870, 646).

***177. Asio wilsonianus.** AMERICAN LONG-EARED OWL.—A not common resident.

***178. Asio accipitrinus.** SHORT-EARED OWL.—Rather common resident.

***179. Syrnium nebulosum.** BARRED OWL.—Rather common resident.

[180.] Ulula cinerea. GREAT GRAY OWL.—Accidental or very rare winter visitor. Recent records are Salem, Nov. 10, 1866 (*Allen*, Am. Nat., III, Jan. 1870, 570); Lynn, 1872 (*Brewer*, Hist. N. Am. Bds., III, 1874, 32); Agawam, Feb. 25, 1883 (*Allen*, Bull. Nutt. Orn. Club, VIII, 1883, 123). A recent Rhode Island record is Wickford, March 25, 1883 (*Jencks*, Bull. Nutt. Orn. Club, VIII, 1883, 183). (For references to some earlier records see *Allen*, Proc. Essex Inst., IV, 1864, 81; Am. Nat., III, 1870, 570; also *Merriam*, Rev. Bds. Conn., 1877, 70.)

181. Nyctala tengmalmi richardsoni. RICHARDSON'S OWL.—Rare winter visitor. Recent records of its occurrence are Lynn, 1863 (*Allen*, Am. Nat., III, 1870, 646); Cambridge, Dec. 1865 (*Maynard*, Nat. Guide, 1870, 133); near Newton, Feb. 26, 1879 (*Brewer*, Proc. Bost. Soc. Nat. Hist., XX, 271). It was taken near Providence, R. I., during winter of 1880–81 (*Jencks*, Bull. Nutt. Orn. Club, VI, 1881, 123), and Dec. 18, 1882 (*Jencks*, ibid., VIII, 1883, 122); and at Hollis, N. H. (*Fox*, ibid., VIII, 1883, 61).

***182. Nyctala acadica.** SAW-WHET OWL.—Rather common and probably resident (see *Deane*, Bull. Nutt. Orn. Club, II, 84). Found breeding at Braintree, June 4, 1880, and five nearly fledged young taken (*Francis*, Bull. Nutt. Orn. Club, VI, 185).

***183. Megascops asio.** SCREECH OWL.—Common resident.

***184. Bubo virginianus.** GREAT HORNED OWL.—A not uncommon resident.

185. Nyctea nyctea. SNOWY OWL.—A more or less regular winter visitant. Very abundant during the winter of 1876–77 (see *Deane*, Bull. Nutt. Orn. Club, II, 1877, 9).

[186.] Surnia ulula caparoch. AMERICAN HAWK OWL.—Very rare winter visitor in most parts of the State; perhaps of rather frequent occurrence in the more elevated parts of Berkshire

County. (See *Allen*, Am. Nat., III, 1869, 569.) There is a recent record of a specimen taken in Framingham in January, 1860 (*Browne*, Auk, II, 1885, 220), and of another taken at Chatham during the winter of 1883–84 (*Allen*, Auk, II, 1885, 383). There was quite an incursion of these birds into northern New England in the autumn of 1884 (*Brewster*, Auk, II, 1885, 108), and one is reported as having been taken near Lynn (*F. B. W*[*ebster*], Orn. and Oöl., X, 1885, 32).

[187.] **Speotyto cunicularia hypogæa.** Burrowing Owl.—Accidental. Newburyport, May 4, 1875 (*Deane*, Rod and Gun, VI, 97, May 15, 1875). This specimen is now in the Museum of Comparative Zoölogy at Cambridge.

*188. **Coccyzus americanus.** Yellow-billed Cuckoo.—Rather frequent summer resident. Somewhat irregularly dispersed, and very variable in respect to numbers in different years.

*189. **Coccyzus erythrophthalmus.** Black-billed Cuckoo.—Common summer resident.

*190. **Ceryle alcyon.** Belted Kingfisher.—Common summer resident. Occasionally met with in winter.

*191. **Dryobates villosus.** Hairy Woodpecker.—A not common resident. More numerous in winter than in summer, when it is generally rare, especially in the eastern part of the State.

*192. **Dryobates pubescens.** Downy Woodpecker.—Rather common resident.

193. **Picoides arcticus.** Arctic Three-toed Woodpecker.—Very rare winter visitor. Recent records are: Middlesex County, fall of 1871 (*Purdie*, Am. Nat., VII, 1873, 693); Hyde Park, last of September, 1878 (*Deane*, Bull. Nutt. Orn. Club, V, Jan. 1880, 56); near Dorchester, Aug. 11, 1883 (*Stearns*, Forest and Stream, XXI, No. 24, Jan. 10, 1884, 474); Plymouth, Dec. 17, 1880 (*Brewster*, Bull. Nutt. Orn. Club, VI, 1881, 182); West Medford, Oct. 16, 1883 (*Bridge*, Journ. Boston Zoöl. Soc., III, Jan. 1884, 17); Lynn, winter of 1860–61 (*Brewster*, Bull. Nutt. Orn. Club, VIII, April, 1883, 122); Woburn and Holbrook, Oct. 1883 (*Brewster*, Auk, I, Jan. 1884, 93).

[194.] **Picoides americanus.** AMERICAN THREE-TOED WOODPECKER.—Very rare or accidental winter visitor. A recent record is Lynn, winter of 1860–61 (*Brewster*, Bull. Nutt. Orn. Club, VIII, April, 1883, 122)—three specimens, two of them previously recorded (*Allen*, Am. Nat., III, 1869, 572).

*195. **Sphyrapicus varius.** YELLOW-BELLIED SAPSUCKER.—Not very common in spring and fall; found occasionally in summer, and a few probably breed, more especially in Berkshire County, where birds with young were found by Mr. Brewster in June, 1883 (Auk, I, Jan. 1884, 12). Marked also as breeding by Dr. Emmons.

*196. **Ceophlœus pileatus.** PILEATED WOODPECKER.—Nearly or quite extirpated from most parts of the State, but still more or less frequent in Berkshire County, and of occasional occurrence in other well wooded portions of the State. A recent record for the eastern part of the State is Boston Highlands, July 20, 1883 (*Bracket*, Journ. Boston Zoöl. Soc., III, 1884, 17). On its occurrence in Berkshire County see *Brewster*, Auk, I, Jan. 1884, 9, 12.

*197. **Melanerpes erythrocephalus.** RED-HEADED WOODPECKER.—Rare summer resident, occasionally breeding. Most frequently observed in fall, and usually in immature plumage. It was unusually common about Boston, as well as in other parts of eastern New England, in the fall of 1881 (*Purdie*, Bull. Nutt. Orn. Club, VII, Jan. 1882, 57).

[198.] **Melanerpes carolinus.** RED-BELLIED WOODPECKER.—A rare straggler. Observed at Springfield, May 13, 1863 (*Allen*, Proc. Essex Inst., IV, 1864, 53); taken at Newton, Nov. 25, 1880 (*Plummer*, Bull. Nutt. Orn. Club, VI, April, 1881, 120); and at Cohasset, May 28, 1881 (*Brewster*, ibid., VI, July, 1881, 183). Also at Suffield, Conn., within a few miles of the Massachusetts line, July 30, 1874 (*Merriam*, Rev. Bds. Conn., 1877, 65). Given also by Emmons and Peabody, but their records were later discredited.

*199. **Colaptes auratus.** FLICKER.—Abundant summer resident. Occasionally seen in winter.

[200.] **Antrostomus carolinensis.** CHUCK-WILL'S-WIDOW.—Accidental. One found dead in a barn in Revere, in December, 1884 (*Osgood*, Auk, II, April, 1885, 220). This specimen is now in the Cambridge Museum of Comparative Zoölogy.

*201. **Antrostomus vociferus.** WHIP-POOR-WILL.—Common summer resident.

*202. **Chordeiles virginianus.** NIGHTHAWK.—Abundant summer resident.

*203. **Chætura pelasgica.** CHIMNEY SWIFT. — Abundant summer resident.

*204. **Trochilus colubris.** RUBY-THROATED HUMMINGBIRD.—Common summer resident.

*205. **Tyrannus tyrannus.** KINGBIRD. — Common summer resident.

[206.] **Tyrannus dominicensis.** GRAY KINGBIRD. — Accidental. Taken in Lynn early in October, 1869 (*Allen*, Am. Nat., III, 1870, 645).

*207. **Myiarchus crinitus.** CRESTED FLYCATCHER. — Rare summer resident.

*208. **Sayornis phœbe.** PHŒBE.—Common summer resident.

*209. **Contopus borealis.** OLIVE-SIDED FLYCATCHER. — Rather uncommon summer resident; in general breeding sparingly, but commonly in Berkshire County (*Brewster*, Auk, I, Jan. 1884, 15).

*210. **Contopus virens.** WOOD PEWEE.—Common summer resident.

*211. **Empidonax flaviventris.** YELLOW-BELLIED FLYCATCHER.—Not uncommon in spring and fall. Breeds in Berkshire County (*Brewster*, Auk, I, 1884, 15).

*212. **Empidonax pusillus traillii.** TRAILL'S FLYCATCHER.—Chiefly spring and autumn visitant. Not common. A few remain in summer and breed. [This is *Empidonax acadicus* of my "Birds of Springfield" (Proc. Essex Inst., IV, 1864, 54), *plus E. traillii* of the same "List.]

*213. **Empidonax minimus.** LEAST FLYCATCHER. — Common summer resident.

214. Otocoris alpestris. HORNED LARK.—Winter visitant, chiefly along the coast, where it is generally common and sometimes abundant.

***215. Cyanocitta cristata.** BLUE JAY.—Common throughthe year.

216. Corvus corax sinuatus. AMERICAN RAVEN. — Very rare. Very few recorded instances of its capture within the State. A recent record is Williamstown, 1877 (*Tenney*, Am. Nat., XI, 243; *Brewster*, Auk, I, Jan. 1884, 10, foot-note). Frequent on the islands off the coast of Maine (*Merrill*, Bull. Nutt. Orn. Club, VI, 249). It has also been recorded from Brandon, Vt.

***217. Corvus americanus.** AMERICAN CROW. — Common resident.

***218. Dolichonyx oryzivorus.** BOBOLINK.—Abundant summer resident.

***219. Molothrus ater.** COWBIRD.—Common summer resident. Has been taken in winter (Belmont, *Spelman*, Bull. Nutt. Orn. Club, VIII, 1883, 121).

[220.] Xanthocephalus xanthocephalus. YELLOW-HEADED BLACKBIRD.—Accidental. Two instances of its capture. First identified from the wings, tail, and foot of a specimen shot by Mr. Frank Sawyer in Watertown, Oct. 15, 1869 (*Allen*, Am. Nat., III, 1870, 636). According to Mr. N. Vickary, of Lynn, two specimens were shot at Eastham, Sept. 10, 1877, by Mr. Loud, of Salem, one of which was preserved (*Allen*, Bull. Essex Inst., X, 1878, 18).

***221. Agelaius phœniceus.** RED-WINGED BLACKBIRD.—Common summer resident.

***222. Sturnella magna.** MEADOW LARK.—Common summer resident; a few sometimes remain in winter.

***223. Icterus spurius.** ORCHARD ORIOLE.—Rare summer resident. More common in the Connecticut Valley than elsewhere in the State.

***224. Icterus galbula.** BALTIMORE ORIOLE.—Abundant summer resident.

225. Scolecophagus carolinus. Rusty Blackbird.—Rather common spring and autumn visitant.

***226. Quiscalus quiscula æneus.** Bronzed Grackle.—Common summer resident.

227. Pinicola enucleator. Pine Grosbeak.—Irregular winter visitant, occurring sometimes in abundance.

***228. Carpodacus purpureus.** Purple Finch.—Rather common summer resident; a few probably remain at some localities during winter.

***229. Loxia curvirostra minor.** American Crossbill.—Irregular winter visitor, but a much more frequent and abundant one than the next species. A few often occur in summer, and occasionally breed (*Browne*, Auk, II, 1885, 105), as they have been found to do on Long Island (Orn. and Oöl., VII, 68), in New Jersey (Forest and Stream, XXII, 302), and elsewhere as far south as Maryland (Auk, I, 292, and II, 379).

230. Loxia leucoptera. White-winged Crossbill.—Irregular and infrequent winter visitant.

231. Acanthis linaria. Redpoll.—An irregular but often abundant winter visitor.

231*a*. Acanthis linaria rostrata. Greater Redpoll. — With the preceding, but much less numerous. (See *Brewster*, Bull. Nutt. Orn. Club, VIII, April, 1883, 95–99, where this form is referred to at length under the name *Ægiothus linaria holboelli.*)

***232. Spinus tristis.** American Goldfinch.—Common throughout the year, but of gregarious and nomadic habits in winter.

233. Spinus pinus. Pine Siskin.—Chiefly spring and autumn migrant; occasionally remains through the winter, and has been known to occur in summer. Marked as breeding by Dr. Emmons. Breeding at Sing Sing, N. Y., May, 1883 (*Fisher*, Bull. Nutt. Orn. Club, VIII, 1883, 180). Also at Rutland, Vt. (Science, III, 216).

234. Plectrophenax nivalis. Snowflake. — Regular and rather common winter visitant.

235. Calcarius lapponicus. Lapland Longspur. —Winter visitant, mainly near the coast; not common.

[236.] '**Calcarius ornatus.** CHESTNUT-COLLARED LONGSPUR. —Accidental. Magnolia, near Gloucester, July 28, 1876 (*Brewer*, Bull. Nutt. Orn. Club, II, 1877, 78).

*__237. Poocætes gramineus.__ VESPER SPARROW.—Abundant summer resident.

238. Ammodramus princeps. IPSWICH SPARROW.—Rather rare but regular winter visitant, occurring chiefly near the coast. Has been met with along the coast from Prince Edward's Island to Delaware.

*__239. Ammodramus sandwichensis savanna.__ SAVANNA SPARROW.—Abundant summer resident along the coast; much less common in the interior.

*__240. Ammodramus savannarum passerinus.__ GRASSHOPPER SPARROW.—Common and even abundant summer resident at favorable localities, especially in the Connecticut Valley and near the sea coast.

*__241. Ammodramus henslowi.__ HENSLOW'S SPARROW.—Rare summer resident, of rather irregular distribution.

*__242. Ammodramus caudacutus.__ SHARP-TAILED SPARROW. —More or less common in the salt marshes along the coast, especially in those of Charles River.

242*a*. Ammodramus caudacutus nelsoni. NELSON'S SPARROW.—Occurs sparingly with the preceding in autumn (*Henshaw*, Auk, III, 1886, —).

243. Ammodramus maritimus. SEA-SIDE SPARROW.—Rare or accidental in the salt marshes along the coast. Only one recent record of its capture in the State—Nahant, Aug. 1877 (*Brewer*, Bull. Nutt. Orn. Club, III, Jan. 1878, 48). Dr. Merriam gives it as a common summer resident in the salt and brackish water marshes of Connecticut (Rev. Bds. Conn., 1877, 38).

[244.] **Chondestes grammacus.** LARK FINCH.—Accidental. Four recorded instances of its occurrence. Gloucester, about 1845 (*Putnam*, Proc. Essex Inst., I, 1856, 224); Newtonville, Nov. 25, 1877 (*Purdie*, Bull. Nutt. Orn. Club, III, 1878, 44); Magnolia, Aug. 29, 1879 (*Townsend*, Bull. Nutt. Orn. Club, V, 53); 1886.]

Framingham, April, 1883 (*Browne*, Bull. Nutt. Orn. Club, VIII, 1883, 181).

245. Zonotrichia leucophrys. WHITE-CROWNED SPARROW. —Rather rare spring and autumn migrant.

***246. Zonotrichia albicollis.** WHITE-THROATED SPARROW. —Abundant spring and autumn migrant. Breeds in Berkshire County (*Emmons;* see also *Brewster*, Auk, I, 1884, 15). Recorded as nesting in Framingham, in June, 1874 (*Browne*, Bull. Nutt. Orn. Club, V, 1880, 52). Taken in winter (Jan. 7, 1882) in Cambridge (*Lamb*, Journ. Boston Zoöl. Soc., I, 1882, 32).

247. Spizella monticola. TREE SPARROW.—Common winter visitant.

***248. Spizella socialis.** CHIPPING SPARROW.—Abundant summer resident.

[249.] Spizella breweri. BREWER'S SPARROW.—Accidental. Watertown, Dec. 15, 1873 (*Brewster*, Am. Nat., VIII, 1874, 366).

***250. Spizella pusilla.** FIELD SPARROW.—Common summer resident.

***251. Junco hyemalis.** SLATE-COLORED JUNCO.—Mainly a spring and autumn visitant; a few are sometimes observed in winter. Breeds abundantly in the more elevated parts of Berkshire County. (See Auk, I, 1884, 14.)

[251*a*.] Junco hyemalis oregonus. OREGON JUNCO.—Accidental. Watertown, March 25, 1874 (*Brewster*, Bull. Nutt. Orn. Club, I, 1876, 19).

***252. Melospiza fasciata.** SONG SPARROW.—Abundant summer resident ; a few sometimes remain in winter in sheltered localities.

253. Melospiza lincolni. LINCOLN'S FINCH. — A rare or casual visitor in spring. Mr. E. I. Shores considers it as not rare at Suffield, Conn., where he believes it sometimes breeds. (See *Merriam*, Rev. Bds. Conn., 1877, 38.) It has also been reported as breeding at Otter Lake, Hamilton Co., N. Y. (*Bagg*, Bull. Nutt. Orn. Club, III, 1878, 197 ; ibid., VI, 1882, 246).

***254. Melospiza georgiana.** SWAMP SPARROW.—A not very common summer resident, of rather local distribution.

255. Passerella iliaca. Fox Sparrow. — Abundant spring and autumn migrant.

***256. Pipilo erythrophthalmus.** Towhee.—Abundant summer resident.

[**257.**] **Cardinalis cardinalis.** Cardinal. — Accidental. Several instances of its occurrence recorded. A recent one is Woburn, Nov. 14, 1882 (*Richards*, Bull. Nutt. Orn. Club, VIII, 1883, 59). It has been taken as far north as Halifax, N. S. (*Jones*, Am. Nat., V, 1871, 176), and is resident in small numbers in Central Park, New York City, in Brooklyn, and on Long Island, N. Y.

***258. Habia ludoviciana.** Rose-breasted Grosbeak. — Common summer resident.

[**259.**] **Guiraca cærulea.** Blue Grosbeak. — Accidental. Taken at Brookline, May 29, 1880, by Mr. Gordon Plummer (*Allen*, Bull. Nutt. Orn. Club, V, 1880, 184). Has also been taken at Grand Menan and Calais, Maine (*Boardman*, Proc. Bost. Soc. Nat. Hist., IX, 1862, 127).

***260. Passerina cyanea.** Indigo Bunting.—Common summer resident.

***261. Spiza americana.** Black-throated Bunting. — Very rare summer resident. Not generally distributed, but of rather frequent occurrence at some localities in the eastern part of the State. (See *Purdie*, Bull. Nutt. Orn. Club, III, 1878, 45; *Brewer*, ibid., III, 1878, 190 ; *Deane*, ibid., IV, 1879, 122.) Has been taken as far north as Penobscot Bay, Maine (*Townsend*, Auk, II, 1885, 106).

[**262.**] **Calamospiza melanocorys.** Lark Bunting.—Accidental. One instance of its capture—Lynn, Dec. 5, 1877, taken by Mr. N. Vickary (*Allen*, Bull. Nutt. Orn. Club, III, 1878, 48).

[**263.**] **Piranga ludoviciana.** Western Tanager.—Accidental. A single specimen was taken alive in Salem, Jan. 20, 1878 (*Brewer*, Forest and Stream, X, 95, March 14, 1878; *Allen*, Bull. Essex Inst., X, 1878, 37, where for " Lynn " read *Salem*).

***264. Piranga erythromelas.** Scarlet Tanager.—Common summer resident.

[265.] **Piranga rubra.** Summer Redbird.—Accidental summer visitor. Several instances of its capture are on record. The most recent is Swampscott, June, 1866 (*Allen*, Bull. Essex Inst., X, 1878, 15). Taken at Grand Menan, May, 1881 (*Batchelder*, Bull. Nutt. Orn. Club, VII, 1882, 249).

*266. **Progne subis.** Purple Martin.—Common summer resident.

*267. **Petrochelidon lunifrons.** Cliff Swallow.—Common summer resident.

*268. **Chelidon erythrogaster.** Barn Swallow.—Common summer resident.

*269. **Tachycineta bicolor.** Tree Swallow.—Common summer resident.

*270. **Clivicola riparia.** Bank Swallow.—Common summer resident.

[271.] **Ampelis garrulus.** Northern Wax-wing.—Accidental in winter. The latest record is Lynn, Feb. 18, 1877 (*Allen*, Bull. Essex Inst., X, 1878, 15).

*272. **Ampelis cedrorum.** Cedar Wax-wing. — Common summer resident; frequently seen in winter in roving flocks, and at localities where it finds a good supply of food.

273. **Lanius borealis.** Great Northern Shrike.—Rather common winter visitant.

274. **Lanius ludovicianus excubitoroides.** White-rumped Shrike.—Casual in migrations. Recent records of its occurrence are West Newton, Oct. 21, 1872 (*Purdie*, Am. Nat., VII, 1873, 115); Newtonville, 1874 (*Maynard*, Am. Sportsman, V, 313, Feb. 13, 1875); Lynn, Nov. 1877 (*Allen*, Bull. Essex Inst., X, 1878, 15); Brookline, Feb. 1879 (*Brewster*, Bull. Nutt. Orn. Club, VI, 1881, 55). More common in portions of Northern New England, where it breeds, as at Bangor, Me. (*Brewer*, Bull. Nutt. Orn. Club, IV, 1879, 119; *Purdie*, ibid., IV, 1879, 186; *Merrill*, ibid., VI, 1881, 250), and Rutland, Vt. (*Brewer*, ibid., IV, 1879, 119).

*275. **Vireo olivaceus.** Red-eyed Vireo. Abundant summer resident.

276. Vireo philadelphicus. PHILADELPHIA VIREO.—Very rare. There are but few records of its occurrence in the State, as follows: Cambridge, Sept. 7, 1875 (*Brewster*, Bull. Nutt. Orn. Club, I, 1876, 19); Magnolia, Sept. 18, 1879 (*Townsend*, ibid., V, 1880, 53); Brookline, Sept. 1880? (*Brewster*, ibid., VI, 1881, 53). It has been found to be a not very uncommon summer resident in northern Maine (see especially *Brewster*, Bull. Nutt. Orn. Club, V, 1880, 1–7).

***277. Vireo gilvus.** WARBLING VIREO.—Common summer resident.

***278. Vireo flavifrons.** YELLOW-THROATED VIREO.—Rather common summer resident.

***279. Vireo solitarius.** BLUE-HEADED VIREO.—Common spring and autumn migrant; a few stay through the summer and breed.

***280. Vireo noveboracensis.** WHITE-EYED VIREO.—More or less common summer resident at certain localities.

***281. Mniotilta varia.** BLACK-AND-WHITE CREEPER.—Common summer resident.

[**282.**] **Protonotaria citrea.** PROTHONOTARY WARBLER.—Accidental. Concord, May 9, 1886 (*Brewster*, Auk, III, 1886, 410). Long since introduced into the lists of New England birds on the basis of its capture at or near Calais, Me. (*Verrill*, Proc. Bost. Soc. Nat. Hist., IX, 1863, 234). The specimen seems to have been captured, however, at St. Stephen's, just within the borders of New Brunswick (*Baird*, *Brewer*, and *Ridgway*, Hist. N. Am. Birds, I, 1874, 184, 186), though still sometimes attributed to Maine (*Stearns* and *Coues*, New England Bird Life, I, 1881, 110; *Smith*, Forest and Stream, XIX, No. 23, Jan. 4, 1883, 445). One was taken at South Kingstown, R. I., April 21, 1884 (*Jencks*, Random Notes on Nat. Hist., I, 1884, No. 5, 8, and No. 6, 8). Its usual northern limit along the Atlantic coast, however, seems to be the vicinity of Philadelphia.

[**283.**] **Helmitherus vermivorus.** WORM-EATING WARBLER.—A rare or accidental straggler from the south. The only record of its capture in the State is Cambridge, Sept. 19, 1881

1886.]

(*Spelman*, Bull. Nutt. Orn. Club, VI, 1881, 246). Mr. Stearns reports having *seen* the species at Easthampton (New England Bird Life, I, 1881, 111). Of quite frequent occurrence in Southern Connecticut, where it has been found breeding (*Woolsey*, Bull. Nutt. Orn. Club, V, 1880, 116; *Sage*, Auk, II, 1885, 305).

[284.] **Helminthophila pinus.** Blue-winged Warbler.—Rare straggler from the south. The two Massachusetts records are Dedham, about 1854 (*Cabot*, Proc. Bost. Soc. Nat. Hist., VI, 386—specimen still extant in the Society's collection), and West Roxbury, May 17, 1878 (*Deane*, Bull. Nutt. Orn. Club, III, 1878, 188). Of frequent occurrence in Southern Connecticut, where it is recorded as regularly breeding, probably in considerable numbers (see *Merriam*, Rev. Bds. Conn., 1877, 14; *Stearns* and *Coues*, New England Bird Life, I, 1881, 112; *Averill*, Orn. and Oöl., IX, 1884, 111).

*285. **Helminthophila chrysoptera.** Golden-winged Warbler.—Summer resident. Not generally common, but more or less frequent at some localities.

*286. **Helminthophila ruficapilla.** Nashville Warbler.—Common summer resident.

[287.] **Helminthophila celata.** Orange-crowned Warbler.—Rare or accidental. Only three instances of its capture thus far on record: Springfield, May 15, 1883 (*Allen*, Proc. Essex Inst., IV, 1864, 60); Lynn, Jan. 1, 1875 (*Brewer*, Proc. Bost. Soc. Nat. Hist., XVII, 439); Concord, Oct. 2, 1876 (*Brewster*, Bull. Nutt. Orn. Club, I, 1876, 94). The only other New England records are Hollis, N. H., May 16, 1876 (*Fox*, Forest and Stream, VI, 354); Cranston, R. I., (*Purdie*, Bull. Nutt. Orn. Club, II, 1877, 21). The Isles of Shoals record (*Murdoch*, ibid., III, 1878, 96), proved erroneous (*Brewster*, ibid., VII, 1882, 53).

288. **Helminthophila peregrina.** Tennessee Warbler.—Rare spring and autumn migrant.

*289. **Compsothlypis americana.** Blue Yellow-backed Warbler.—Rather common summer resident.

290. **Dendroica tigrina.** Cape May Warbler.—Rather rare spring and autumn migrant.

[*July*,

*291. **Dendroica æstiva.** Yellow Warbler.—Abundant summer resident.

*292. **Dendroica cærulescens.** Black-throated Blue Warbler.—Chiefly a spring and fall migrant. It breeds, however, in Berkshire County (*Brewster*, Auk, I, 1884, 12, 15), and has been observed in summer in other portions of the State. Breeds also in the Catskills (*Trippe*, Am. Nat., VI, 1872, 47), and has been found nesting in Connecticut (*Jones*, Bull. Nutt. Orn. Club, I, 1876, 11; Orn. and Oöl., VI, 1881, 49; IX, 1884, 30, 31).

293. **Dendroica coronata.** Yellow-rumped Warbler.—Abundant spring and autumn migrant. A few known to winter on Cape Cod. May breed in portions of Berkshire County, as Mr. Jenness Richardson informs it does on Killington Mountain, near Rutland, Vt., and also on the island in Lake Bombazine—localities within about fifty miles of the Massachusetts line.

[294.] **Dendroica auduboni.** Audubon's Warbler.—Accidental. Cambridge, Mass., Nov. 15, 1876 (*Frazar*, Bull. Nutt. Orn. Club, II, 1877, 27).

*295. **Dendroica maculosa.** Black-and-yellow Warbler.—Common spring and autumn migrant. Breeds in the higher parts of Berkshire County (*Brewster*, Auk, I, 1884, 11, 13), and has been observed a few times elsewhere in the State in summer.

*296. **Dendroica pennsylvanica.** Chestnut-sided Warbler.—Common summer resident.

297. **Dendroica castanea.** Bay-breasted Warbler.—Spring and autumn migrant, varying greatly in abundance in different years.

298. **Dendroica striata.** Black-poll Warbler.—Abundant spring and autumn migrant. Mr. Jenness Richardson informs me that it is a common summer resident about Castleton, Vt.

*299. **Dendroica blackurniæ.** Blackburnian Warbler.—Common spring and autumn visitant, some remaining through the summer. Breeds in Berkshire County (*Brewster*, Auk, I, 1884, 15).

[300.] **Dendroica dominica.** Yellow-throated Warbler.—A casual or accidental visitor. The only Massachusetts record is

1886.]

Dedham, about 1868 (*Purdie*, Bull. Nutt. Orn. Club, III, 1878, 146). It is recorded as an accidental visitor to Connecticut (*Merriam*, Rev. Bds. Conn., 1877, 17).

***301. Dendroica virens.** BLACK-THROATED GREEN WARBLER.—Common summer resident.

***302. Dendroica vigorsii.** PINE WARBLER.—Common summer resident. Occasionally stays in winter (Framingham, *Hogg*, Journ. Boston Zoöl. Soc., I, 25 ; Duxbury, Dec. 1882, *Brewster*, Bull. Nutt. Orn. Club, VIII, 1883, 120).

[303.] Dendroica palmarum. PALM WARBLER.— Rare. Brookline, Oct., 1878 (*Deane*, Bull. Nutt. Orn. Club, IV, 1879, 60, 186) ; Cambridge, Sept. 13, 1880, and Belmont, Sept. 7, 1881 (*Spelman*, ibid., VII, 1882, 54), and Sept. 29, 1883 (*Lamb*, Journ. Boston Zoöl. Soc., II, 1883, 55).

303*a*. Dendroica palmarum hypochrysea. YELLOW PALM WARBLER.—Abundant spring and autumn migrant ; a few have been observed at favorable localities in winter.

***304. Dendroica discolor.** PRAIRIE WARBLER.—Common summer resident near the seaboard ; less common in the interior.

***305. Seiurus aurocapillus.**—GOLDEN-CROWNED THRUSH.— Abundant summer resident.

***306. Seiurus noveboracensis.** WATER-THRUSH.—Rather common spring and autumn migrant. Some remain in summer, and it is recorded as breeding near Boston (*Brewer*, Hist. N. Am. Birds, I, 1874, 285).

[307.] Seiurus motacilla. LOUISIANA WATER-THRUSH.— Rare or accidental. One record of its capture (Mount Tom, April 28, 1869, *Allen*, Am. Nat., III, 1870, 557). It has been found breeding near Norwich, Conn. (*Ingersoll*, Am. Nat., VIII, 238), and at Saybrook in the same State (*Sage*, Orn. and Oöl., VII, 1882, 145). Merriam gives it as "not rare in Southern Connecticut, where it breeds regularly, and probably in considerable numbers" (Rev. Bds. Conn., 1877, 20). It has been taken also at Lake George, N. Y., May 16, 1881 (*Fisher*, Bull. Nutt. Orn. Club, VI, 1881, 245), and in Rhode Island (*Deane*, ibid., V, 1880, 116; *Jencks*, Orn. and Oöl., VII, 1882, 114).

308. Geothlypis agilis. CONNECTICUT WARBLER.—A very rare spring but not uncommon fall migrant; sometimes abundant in autumn in the vicinity of Cambridge. Probably more common in other parts of the State at that season than is generally supposed. Spring records are: Readville, May 24, 1883 (*Maynard*, Journ. Boston Zoöl. Soc., II, 1883, 43); Ashland, five specimens, spring, 1883 and 1884 (*Castle*, Orn. and Oöl., IX, 1884, 75). Erroneous spring records for New England are New Haven, Conn. (*Woolsey*, Bull. Nutt. Orn. Club, V, 1880, 117); Bangor, Maine (*Merrill*, Bull. Nutt. Orn. Club, II, 1877—corrected, *Merrill*, Auk, III, 1886, 413).

***309. Geothlypis philadelphia.** MOURNING WARBLER.—Rare spring and autumn migrant, in most parts of the State, but a summer resident, breeding numerously, in the higher portions of Berkshire County (*Brewster*, Auk, I, 1884, 14, 15).

***310. Geothlypis trichas.** MARYLAND YELLOW-THROAT.—Abundant summer resident.

***311. Icteria virens.** YELLOW-BREASTED CHAT.—Rare summer resident. There are records of its nesting in various parts of the State, particularly in Essex County, where it is locally frequent.

[312.] Sylvania mitrata. HOODED WARBLER.—Accidental or casual. The only authentic record is Brookline, June 25, 1879 (*Deane*, Bull. Nutt. Orn. Club, V, 1880, 117). Not uncommon and breeding about Saybrook, in Southern Connecticut (*Purdie*, Am. Nat., VII, 1873, 692; Bull. Nutt. Orn. Club, I, 1876, 73; ibid., II, 1877, 21; *Clark*, Orn. and Oöl., VI, 1882, 9, 102).

313. Sylvania pusilla. WILSON'S WARBLER.—Rather rare spring and autumn migrant.

***314. Sylvania canadensis.** CANADIAN WARBLER.—Common spring and autumn migrant. Occasionally seen in summer, and breeds commonly in Berkshire County (*Brewster*, Auk, I, 1884, 9, 15). Also recorded as breeding in Essex County (*Brewer*, Bull. Nutt. Orn. Club, III, 1878, 139).

***315. Setophaga ruticilla.** AMERICAN REDSTART.—Rather common summer resident.

316. Anthus pensilvanicus. AMERICAN PIPIT.—Spring and autumn visitant, in small flocks. Has been taken in June at Swampscott (*Brewer*, Bull. Nutt. Orn. Club, III, 1878, 194).

***317. Mimus polyglottos.** MOCKINGBIRD.—Rare summer visitant, occasionally breeding, particularly in the Connecticut Valley. Also recorded as breeding in Arlington, near Boston (*Townsend*, Auk, I, 1884, 192). The Mockingbird is given as a "rare summer visitant" to Connecticut (*Merriam*, Rev. Bds. Conn., 1877, 7), and is recorded as breeding repeatedly near Jewett City (*Prior*, Orn. and Oöl., IX, 1884, 115).

***318. Galeoscoptes carolinensis.** CAT-BIRD.—Abundant summer resident.

***319. Harporhynchus rufus.** BROWN THRASHER.—Abundant summer resident.

[320.] Thryothorus ludovicianus. CAROLINA WREN.—Rare. Reported as occurring in Roxbury, in the summer of 1877 (*Minot*, Bull. Nutt. Orn. Club, I, 1876, 76 ; Land Birds and Game Birds of New England, 1877, 74). A specimen was taken in Lynn, July 6, 1878 (*Brewer*, Bull. Nutt. Orn. Club, III, 1878, 193), and in Brookline, Nov. 4, 1883 (*Cory*, Auk, I, 1884, 91). It has been taken at Rye Beach, N. H. (*Spelman*, Bull. Nutt. Orn. Club, VI, 1881, 54), and there are various recent records for Connecticut, Rhode Island, Long Island, and the vicinity of New York City.

***321. Troglodytes aëdon.** HOUSE WREN.—Rather common summer resident.

***322. Troglodytes hiemalis.** WINTER WREN.—Winter visitant ; not common. Breeds in the higher mountainous portions of Berkshire County (*Brewster*, Auk, I, 1884, 15, etc.). It is also recorded as breeding at Lynn (*Brewster*, Bull. Nutt. Orn. Club, VIII, 1883, 119).

***323. Cistothorus stellaris.** SHORT-BILLED MARSH WREN.—Locally common.

***324. Cistothorus palustris.** LONG-BILLED MARSH WREN.—Common, like the preceding, at favorable localities.

[*July*,

***325. Certhia familiaris americana.** BROWN CREEPER.—Resident, occasionally breeding, but most numerous in spring, autumn, and winter.

***326. Sitta carolinensis.** WHITE-BREASTED NUTHATCH.—Rather common resident.

***327. Sitta canadensis.** RED-BREASTED NUTHATCH.—Winter visitant. Not generally common. The supposed instance of its breeding "on the ground, in Roxbury," May, 1877 (recorded in Am. Nat., XI, 565), proves to have been a mistake, the eggs taken being not those of that species. Mr. Brewster reports it as breeding in Berkshire County (Auk, I, 1884, 15).

***328. Parus atricapillus.** CHICKADEE.—Common resident.

[329.] Parus hudsonicus. HUDSONIAN CHICKADEE.—Accidental. The records are Concord, Oct. 30, 1870 (*Brewster*, Am. Nat., VI, 1872, 306) and Oct. 7, 1880 (*Brewster*, Bull. Nutt. Orn. Club, VI, 1881, 54); Cambridge, Dec. 31, 1880 (*Spelman*, Bull. Nutt. Orn. Club, VI, 1881, 114); Quincy, March 14, 1885 (——, Orn. and Oöl., X, 1885, 64). It was also given as a bird of the State by Peabody (Rep. Orn. Mass., 1839, 402). Its capture at Smithfield, R. I. (*Jencks*, Bull. Nutt. Orn. Club, VI, 1881, 54), is also of interest in this connection.

330. Regulus satrapa. GOLDEN-CROWNED KINGLET.—Chiefly a winter visitant, occurring in variable abundance in different years, but usually is more or less common. Probably breeds in portions of Berkshire County, as it has been reported to do in the Catskills (*Trippe*, Am. Nat., VI, 1872, 47).

331. Regulus calendula. RUBY-CROWNED KINGLET.—Abundant spring and autumn visitant.

[332.] Polioptila cærulea. BLUE-GRAY GRATCATCHER.—Accidental or casual. There are, however, several records of its occurrence, as follows: Chatham, Nov. 18, 1877 (*Deane*, Bull. Nutt. Orn. Club, III, 1878, 45); Falmouth, Dec. 18, 1877 (*Brewer*, ibid., III, 1878, 146); Osterville, Cape Cod, Sept. 26, 1879 (*Brewer*, Proc. Bost. Soc. Nat. Hist., XX, 1879, 264); Magnolia, Aug. 27, 1879 (*Deane*, Bull. Nutt. Orn. Club, V, 1880, 47). It has been taken at Cape Elizabeth, Me. (*Brown*, ibid., V, 1880, 1886.]

236), and there are several recent instances of its capture near Providence, R. I. (*Purdie*, ibid., II, 1877, 20), and in Connecticut (*Merriam*, Rev. Bds. Conn., 1877, 8; *Sage*, Bull. Nutt. Orn. Club, VIII, 1883, 179; Auk, III, 1886, —).

***333. Turdus mustelinus.** WOOD THRUSH.—Common summer visitant, except in the higher portions of Berkshire County.

***334. Turdus fuscescens.** WILSON'S THRUSH.—Common summer resident.

335. Turdus aliciæ. GRAY-CHEEKED THRUSH.—Common spring and fall migrant.

335*a*. Turdus aliciæ bicknelli. BICKNELL'S THRUSH.—"Regular and rather common spring and fall migrant.... Some seasons it is more numerous than the true *aliciæ*" (*Brewster, in lit.*). First recorded from Massachusetts by Mr. Brewster in 1883 (Bull. Nutt. Orn. Club, VIII, 1883, 17).

***336. Turdus ustulatus swainsonii.** OLIVE-BACKED THRUSH. —Common spring and autumn migrant. Probably breeds in portions of Berkshire County, where Mr. Brewster found it common in June, 1883 (Auk, I, 1884, 12, 15).

***337. Turdus aonalaschkæ pallasii.** HERMIT THRUSH.—Spring and fall migrant, except in the mountainous portions of the State west of the Connecticut Valley, where it is a common summer resident; also occasionally breeds in other parts of the State, notably in Barnstable County, in parts of which it is a not uncommon summer bird.

***338. Merula migratoria.** AMERICAN ROBIN.—Abundant summer resident; a few remain during winter at favorable localities.

[339.] Hesperocichla nævia. VARIED THRUSH.—Accidental. As yet the only authentic record of its occurrence is its capture at Ipswich, in December, 1864 (*Allen*, Proc. Essex Inst., V, 1868, 312; Am. Nat., III, Jan. 1870, 572; see further, on its supposed earlier occurrence in Massachusetts, Proc. Essex Inst., IV, 1864, 82).

***340. Sialia sialis.** BLUEBIRD.—Abundant summer resident.

[*July*,

II.—EXTIRPATED SPECIES.

1. **Plautus impennis.** GREAT AUK.—The former existence of this species in Massachusetts is attested by the occurrence of its bones in the Indian shell-heaps of the coast, particularly at Ipswich, and there are also unquestionable allusions to its presence on Cape Cod at the time the coast was explored by Gosnold in 1602 (see Bull. Nutt. Orn. Club, I, 1876, 59).

2. **Grus americana.** WHOOPING CRANE.—This species was given by Emmons in 1833 as a rare but regular visitant, but there is no later record of its occurrence. It unquestionably occurred here at the time of the first settlement of the country, in common with the following species.

3. **Grus mexicana.** SANDHILL CRANE. — Unquestionably more or less abundant two hundred years ago (see Bull. Nutt. Orn. Club, I, 1876, 58), but there is no recent record of its occurrence.

4. **Meleagris gallopavo.** WILD TURKEY.—Well known to have been a common species in Southern New England for a long time subsequent to the first settlement of this part of the country (see Bull. Nutt. Orn. Club, I, 1876, 55), but long since ceased to exist here in a wild state. Considered as nearly extinct by Emmons in 1833, but said by Hitchcock to be at that time "frequently met with on Mount Holyoke" (Rep. Geol. Mass., etc., 1833, 549).

Other species virtually extirpated, are the Prairie Hen (*Tympanuchus cupido*), now restricted to Martha's Vineyard, where a few representatives of this formerly rather common species still exist (see *antea*, p. 241); the Whistling Swan (*Olor columbianus*), now only a rare straggler, and probably also the Trumpeter Swan (*Olor buccinator*). To these may doubtless be added the Labrador or Pied Duck (*Camptolaimus labradorius*). (See *Rowley*, Orn. Miscel., pt. VI, 1877, 205–333; also Bull. Nutt. Orn. Club, III, 1878, 79).

III.—SPECIES OF PROBABLE OCCURRENCE.

Of the following list of nineteen species, the greater part have been included in various former lists of the birds of Massachusetts, but generally on inferential evidence, or on erroneous identification. About one-fourth of them have been taken within a few miles of the southern boundary of the State, and others, from their known general range, must evidently occur at rare intervals. At least one-half of the species named below have already been taken in adjoining States at points not far from the Massachusetts line.

1. Larus kumlieni. KUMLIEN'S GULL.—As several specimens of this recently described species have been taken near the eastern coast of Maine (Grand Menan and Bay of Fundy), and one at Troy, N. Y., it may reasonably be expected to occur as a straggler to the coast of Massachusetts.

2. Procellaria pelagica. STORMY PETREL.—This species was formerly included as a bird of Massachusetts, but there seems to be no positive record of its occurrence south of the Newfoundland Banks. Its capture off the New England coast, as far south even as Massachusetts, would not be surprising, since at present our off-shore birds are by no means well-known.

3. Fregata aquila. MAN-O'-WAR BIRD.—As this southern species has been taken on Faulkner's Island, Conn. (*Grinnell*, Am. Nat., IX, 1865, 470), at Booth Bay, Maine (*Purdie*, in Stearns and Coues's New England Bird Life, II, 1883, 342), and in Nova Scotia (*Deane*, Bull. Nutt. Orn. Club, IV, 1879, 64), it may be entered in the present list as a possible accidental visitor to Massachusetts.

4. Anas penelope. WIDGEON.—This European species, formerly given as a bird of Massachusetts, still lacks confirmation as a bird of the State, or even of New England. It has been taken on Long Island, in New Jersey, and southward to Florida, and also in Greenland, and may well be expected to occur in Massachusetts.

5. Anas crecca. EUROPEAN TEAL.—Occurs as a straggler in eastern North America, having been taken at various points from

Labrador to the Carolinas, but there are as yet no New England records.

6. Olor buccinator. Trumpeter Swan.—In all probability common here two hundred years ago, and may still occur as a straggler. Although there is no recent record of its capture within the State, there is a comparatively recent reference to its supposed occurrence at East Windsor Hill, Conn. (March, 1876), within fifteen miles of the Massachusetts line (*Merriam*, Rev. Bds. Conn., 1877, 120). In several instances where the occurrence of Swans is recorded, there is some doubt as to the species, owing to unsatisfactory identification.

7. Guara alba. White Ibis.—Has been recorded from Connecticut (*Grinnell*, Am. Nat., IX, 1875, 470), South Woodstock, Vt. (*Tracy*, Orn. and Oöl., X, 1885, 10), and repeatedly from Long Island. The species may occur as an accidental visitor to Massachusetts.

8. Crex crex. Corn Crake.—Of casual occurrence in eastern North America. Was taken at Cranston, R. I., about 1857 (*Jencks*, Random Notes on Nat. Hist., I, 1884, No. 6, 3), and has been taken in several instances on Long Island; also at Troy, N. Y. (*Park*, Forest and Stream, XXII, Feb. 14, 1884, 44), and Salem, New Jersey (*Cassin*, Proc. Acad. Nat. Sci. Phila., 1855, 265); also in Greenland and the Bermudas.

9. Scolopax rusticola. European Woodcock.—Occasional in eastern North America. There are records of its occurence in Newfoundland, Maine, Long Island, New Jersey, Virginia, and elsewhere in the Atlantic States.

10. Milvulus forficatus. Swallow-tailed Flycatcher.—This erratic species has been taken at Wauregan, Conn. (*Purdie*, Bull. Nutt. Orn. Club, II, 1877, 21); St. Johnsburg, Vt. (*Jencks*, Random Notes on Nat. Hist., I, 1884, No. 8, 3); Trenton, N. J. (*Abbott*, Am. Nat., VI, 1872, 367); in Manitoba, and at York Factory, Hudson's Bay (*Seton*, Auk, II, 1885, 218).

11. Tyrannus verticalis. Arkansas Kingbird.—This western species has been taken at Elliot (="Plympton"), Maine (*Bryant*, Proc. Bost. Soc. Nat. Hist., X, 1865, 96; *Purdie*, Bull.

Nutt. Orn. Club, I, 1876, 73), Riverdale, N. Y. (*Bicknell*, ibid., IV, 1879, 60), and at Moorestown, N. J. (*Turnbull*, Bds. Eastern Penn., 1869, 41), and is as likely to occur in Massachusetts as many other species which have been taken there.

12. Empidonax acadicus. ACADIAN FLYCATCHER.—Has been taken at Suffield, Conn. (*Merriam*, Rev. Bds. Conn., 1877, 58), within about six miles of the Massachusetts line. Recorded by me in 1864 as occurring at Springfield, but in this instance *E. pusillus traillii* was mistaken for it, as heretofore stated (Proc. Essex Inst., X, 1878, 33).

13. Perisoreus canadensis. CANADA JAY.—Has been taken at Portland, Me. (*Brown*, Bull. Nutt. Orn. Club, VII, 1882, 122), and at Brandon, Vt. (*Knowlton*, ibid., VII, 1882, 64). Mr. Jenness Richardson informs me that there is a small resident colony of these birds near Rutland, Vt., about fifty miles north of the Massachusetts line, where he has often shot the birds. It doubtless occurs as an occasional winter visitor in Berkshire County. Mr. C. J. Maynard reports seeing "an individual in Newtonville" "in early summer," about 1875 (Bds. East. N. Amer., 1879, 168), but it eluded capture, and there is, so far as known to me, no record of its actual capture in the State. Mr. George N. Lawrence, however, reports the capture of a specimen "on New York Island, near Manhattanville," in midsummer (Ann. N. Y. Lyc. Nat. Hist., VIII, 1866, 289), a very unusual season for this bird to be seen so far south.

14. Corvus ossifragus. FISH CROW.—This species is now well known to be a not very rare resident on Long and Staten Islands, and in the lower Hudson Valley (*Zerega*, Bull. Nutt. Orn. Club, V, 1880, 205; *Mearns*, Bull. Essex Inst., XII, 1880, 110–112; *Purdie*, ibid., V, 1880, 240; *Dutcher*, Trans. Linn. Soc. New York, I, 1882, 109–111). There is also an old Connecticut record (*Linsley*, Am. Journ. Sci. and Arts, XLIV, 1843, 260). Mr. William Brewster observed a single individual in Cambridge, March 16, 1875 (Bull. Nutt. Orn. Club, I, 1876, 73), but there is thus far no record of the actual capture of the species within the State.

15. Stelgidopteryx serripennis. ROUGH-WINGED SWALLOW. —This species has been found breeding at West Point, N. Y.

(*Mearns*, Bull. Nutt. Orn. Club, III, 1878, 46), and at Green's Farms, twenty-six miles west of New Haven, Conn., in 1876 and 1877 (*Stannis*, Bull. Nutt. Orn. Club, IV, 1879, 119). It was taken by Mr. E. I. Shores at Suffield, Conn., June 6, 1874 (ibid., II, 1877, 21)—a locality only a few miles south of the Massachusetts line. Mr. John H. Sage also writes me that it was killed at East Hartford, Conn., in June, 1885. Its occasional presence in Massachusetts can, therefore, be scarcely questioned, although there is as yet no record of its actual capture within the State.

16. Dendroica cærulea. CERULEAN WARBLER.—Has occurred at Suffield, Conn., close to the Massachusetts boundary (*Purdie*, Bull. Nutt. Orn. Club, II, 1877, 22), and at Cumberland Hill, R. I. (*Deane*, ibid., IV, 1879, 185), and is quite likely to be found sooner or later within the State.

17. Geothlypis formosa. KENTUCKY WARBLER.—This species has also been taken at Suffield, Conn. (*Merriam*, Rev. Bds. Conn., 1877, 22). This is its only New England record, but it has been taken at Sing Sing, N. Y. (*Fisher*, Am. Nat., IX, 1875, 573), and also in Northern New Jersey.

18. Parus bicolor. TUFTED TITMOUSE.—This species, which occurs sparingly as far north as Long Island and the vicinity of New York City, has several Connecticut records (see *Merriam*, Rev. Bds. Conn., 1877, 9), and has once occurred as near the Massachusetts border as Hartford. There is also an early New Hampshire record (*Belknap*, Hist. New Hampshire, III, 1792, 173).

19. Saxicola œnanthe. WHEATEAR.—Of frequent occurrence in Southern Labrador, where it breeds, and in the Bermudas, and has been taken at Quebec, Canada (*Baird*, Rev. Am. Bds., 1864, 61); Indian Island, near Eastport, Maine (*Boardman*, Bull. Nutt. Orn. Club, V, 1880, 115), and on Long Island, N. Y. (*Lawrence*, Ann. N. Y. Lyc. Nat. Hist., VIII, 1866, 282). Its capture in Massachusetts is therefore not improbable.

The **Crested Grebe** (*Colymbus cristatus*), formerly included among Massachusetts birds, has recently been found to have no status as even a bird of North America.

The **Manx Shearwater** (*Puffinus puffinus*), formerly given as more or less frequent off the coast in winter, is now considered as of doubtful occurrence off the eastern coast of North America, there being no authentic record of its capture on the American side of the Atlantic, south of Greenland.

The two species of **Tropic Bird** occasionally straggle far beyond their usual range. The Yellow-billed Tropic Bird (*Phaëthon flavirostris*) is reported to have been taken "in the interior of New York State about the middle of November, 1870" (*Maynard*, Bds. East. N. Amer. 1879, 474), and the Red-billed Tropic Bird (*P. æthereus*) is said to be "casual near Newfoundland Banks" (*Ridgway*, Water Birds N. Amer., II, 1884, 189).

The **Willow Ptarmigan** (*Lagopus albus*), of which a specimen was taken in Manchester, in May, 1859 (*Coues*, Proc. Essex Inst., V, 1868, 259), is doubtless to be regarded as an escaped cage-bird rather than as a species intentionally introduced, or even as an accidental waif.

The **Serin Finch** (*Serinus hortulanus*), which has but a single record for the State (*Allen*, Am. Nat., III, 1870, 635), or even for North America, may also doubtless be considered as an escaped cage-bird.

The **Evening Grosbeak** (*Coccothraustes vespertina*) has been taken at Toronto (*Seton*, Auk, II, 1885, 334), and at Woodstock (*McIlwraith*, Proc. Essex Inst., V, 1866, 88) and London, Ontario (*Morden* and *Saunders*, Can. Nat. and Sports., II, 1882, 185. Also in Onondaga County, N. Y. (*Coues*, Bull. Nutt. Orn. Club, VII, 1882, 250), at Elizabethtown, Essex Co., N. Y. (*Brewer*, Proc. Bost. Soc. Nat. Hist., XVII, 1875, 451), and near New York City (*Lawrence*, Ann. Lyc. Nat. Hist. New York, VIII, 1866, 289). It may doubtless be looked for as an accidental visitor to Massachusetts.

Linnæus's Emerald (*Thaumatias linnæi*). A specimen of this species has been recorded as taken in Massachusetts (*Allen*, Am. Nat., III, 1870, 645), but the evidence of its capture in the State has since been found unsatisfactory, while the probabilities are evidently against such an occurrence.

The **Empidonax pygmæus** (*Minot*, Land Birds and Game Birds of New England, 1877, 290), described from a bird "caught sight of.... in some shrubbery.... near Boston," is not recognized as having any scientific status.

IV.—DOUBTFUL SPECIES.

1. **Acanthis brewsteri.** Brewster's Linnet.—The type-specimen of this supposed species, taken at Waltham, by Mr. Brewster (*Ridgway*, Am. Nat., VI, 1872, 433) remains unique. It is now thought to be possibly a hybrid between *Acanthis linaria* and *Spinus pinus* (see *Brewster*, Bull. Nutt. Orn. Club, VI, 1881, 225).

Helminthophila leucobronchialis. Brewster's Warbler.—This supposed species was first taken at Newtonville, May 18, 1870 (*Brewster*, Bull. Nutt. Orn. Club, I, 1876, 1, pl. i). Numerous specimens have since been taken, particularly in southern Connecticut and in the lower Hudson Valley. (For a full citation of references and analysis of the specimens see *Ridgway*, Auk, II, 1885, 359–363.) This and *H. lawrencei* seem likely to be simply hybrids between *H. chrysoptera* and *H. pinus* (*Brewster*, Bull. Nutt. Orn. Club, VI, 1881, 218–225; Auk, III, 1886, 411).

The **Small-headed Flycatcher** (*Muscicapa minuta* Wilson), which has been twice reported as occurring in Massachusetts, but of which no specimens from anywhere are extant, is considered as too problematical to be entitled to recognition. Whatever it may finally prove to be, the Massachusetts records are too vague to have any value.

V.—INTRODUCED SPECIES.

1. **Tympanuchus americanus.** Prairie Hen.—Small numbers of these birds have been repeatedly liberated in various parts of the State, particularly in Barnstable County. Mr. William Brewster, who has given special attention to the matter, says, in a recent letter to me (dated 31st Dec., 1885), "I know of several cases where western Grouse [meaning the present species] have been turned out in Massachusetts within the past eight or ten years....Only last winter a marketman in Boston told me he had some twenty odd sent in by a gunner in *Berkshire County*....A few days latter he showed me a letter from his gunner who said that he did not dare kill any more because a sportsman's club which had procured the birds from the West,

and which was trying to stock the County with them, had found out that he was killing them and threatened to arrest him.

"I have also heard that within three years many western Grouse have been turned out on the Cape. The people who get and liberate them usually try to keep it a secret, believing that if it is known the market gunners will at once go for them. In short, while it is difficult to get proofs of the fact, I have no doubt that hundreds of Grouse from west of the Mississippi have been quietly introduced in Massachusetts within the last ten years."

Many years since they were introduced from the West to Naushon Island, but appear to have soon become exterminated. As stated above, they have since been liberated in Barnstable County, where several have recently been killed. They doubtless would thrive and increase there if they could be protected from the rapacity of unprincipled gunners.

2. Coturnix coturnix. EUROPEAN QUAIL.—During the last ten years a considerable number of these birds have been imported and turned out in various parts of the State, and also in neighboring States. So far as now known, the experiment has not been attended with very encouraging success. A few instances of their breeding have been reported, but in the main the birds have been lost sight of, so that the attempt at their naturalization has been practically a failure. (For a history of their introduction, etc., see Forest and Stream, issues of June 28, Aug. 2, Aug. 9, Aug. 23, Sept. 6, Nov. 15, Nov. 29, Dec. 6, and Dec. 27, 1877.)

3. Carduelis elegans. EUROPEAN GOLDFINCH.—Of late years this species has been repeatedly met with in a wild state in the vicinity of Cambridge and elsewhere near Boston, where doubtless it may be considered as fairly established, as it certainly seems to be in the vicinity of New York, near which city it is known to have been turned out in numbers a few years ago (*Adney*, Auk, III, 1886, 409). It has also been taken at Falmouth, Mass. (*Swift*, Orn. and Oöl., IX, 1884, 12).

4. Passer domesticus. HOUSE SPARROW.—This introduced pest appears to have now spread to all parts of the State, at least to all the larger towns and their immediate neighborhoods, and to have become everywhere ineradicably established, greatly to the regret of all lovers of our native song-birds, to whom this intruder proves so great a nuisance.

GENERAL SUMMARY.

Fully authenticated as birds of the State,*	340
Extirpated, ...	4
Given as of probable occurrence, ...	19
Considered as fairly entitled to recognition as Massachusetts birds,	359
Known as breeding within the State (about), ...	142
Extremely rare or accidental visitors, ...	79
Introduced, ...	4
Species added since 1878, ...	23

* Excluding nine varieties of species otherwise represented.

ARTICLE XVI. — *The Masked Bob-white (Colinus ridgwayi) of Arizona, and its Allies.*—By J. A. ALLEN.

THE Masked or Arizona Bob-white is a comparatively recent addition to the bird fauna of North America, it having been described and named by Mr. William Brewster in April, 1885,* from a single male specimen taken in the State of Sonora, Mexico, a few miles south of the Arizona line, August 11, 1884, by Mr. F. Stephens. The species, however, had been previously mentioned as a bird of Arizona, but under other names, through erroneous identifications. Thus the "*Ortyx virginianus*," reported from Arizona as early as March 6, 1884, by Mr. Herbert Brown,† was in reality the present species. Mr. Brown's specimens then referred to were subsequently seen by Mr. Stephens, and are those mentioned by Mr. Brewster‡ as examined by Mr. Stephens, although this fact was not made known till nearly two years later, when it was first stated by Mr. Brown.‖ In replying to Mr. Brown's reference to the supposed occurrence of *Ortyx virginianus* in Arizona, Mr. Robert Ridgway¶ conjectured that the species thus recorded was either the Massena Quail (*Cyrtonyx massena*) or one of the Mexican species of *Ortyx*, probably *O. graysoni*. Later a nearly complete skin of a female, and fragments of the skin of a male, were sent by Mr. Brown to Dr. George Bird Grinnell, the editor of "Forest and Stream," who submitted them to Mr. Ridgway for identification. From an examination of these imperfect materials Mr. Ridgway pronounced the species to be *Ortyx graysoni* (quite justifiably, as will be shown later), and it was thus recorded by Dr. Grinnell.** These fragmentary specimens†† are those mentioned above as seen by Mr. Stephens.

The next reference to the species is the original description, already cited, of *Colinus ridgwayi* by Mr. Brewster, who does

* Auk, Vol. II, April, 1885, pp. 199, 200.

† Forest and Stream, Vol. XXII, No. 6, March 6, 1884, p. 104.

‡ Auk, Vol. II, 1885, p. 200.

‖ Forest and Stream, Vol. XXV, No. 23, Dec. 31, 1885, p. 445.

¶ Ibid., Vol. XXII, No. 7, March, 13, 1884, p. 124.

** Ibid., Vol. XXII, No. 13, April 24, 1884, p. 243.

†† These specimens are now in the National Museum at Washington. Through the kindness of Mr. Ridgway I have recently had the opportunity of seeing these interesting, and now historic, relics.

not appear to have then been aware that the Arizona specimens referred to in his paper as seen by Mr. Stephens were those already recorded by Dr. Grinnell under the name *Ortyx graysoni.*

Some months later an important paper appeared by Mr. Brown, entitled "Arizona Quail Notes."* It is devoted mainly to an account of the habits and distribution of *Colinus ridgwayi*, with important historical comment on its previous records. Three additional specimens are incidentally mentioned, but not described.† The supposed *Ortyx graysoni* is now, for the first time, unqualifiedly referred to *C. ridgwayi.*

Mr. Brown's article quickly called forth a short paper by Mr. Ridgway, entitled "Arizona Quail,"‡ in which he still maintained the opinion that his first identification of *Ortyx graysoni* from Arizona was correct; at least he did not think that Mr. Brown had "demonstrated the specific identity of *Colinus ridgwayi* Brewst. and the pair of birds, sent by Mr. Brown to Mr. Grinnell, which I [Ridgway] identified as *Ortyx* (now *Colinus*) *graysoni* Lawr." Mr. Ridgway had then, however, seen no other specimens, and guardedly adds: "I would note that much additional material, including specimens in much better shape than those already examined, is necessary to determine the question of whether *C. graysoni* occurs in Arizona, and also that of its relation to *C. ridgwayi.*" Mr. Ridgway's material had consisted practically of a badly prepared or half-mummified female, the few fragments of the male skin examined being non-characteristic; and the females of the species of *Colinus* occurring along the southwestern border of the United States are, as Mr. Ridgway adds, "practically indistinguishable from one another."

The next notice of the Arizona Bob-white is my short reference, published three months since,‖ to Mr. Brown's recently collected material which forms the basis of the present paper. Mr. W. E. D. Scott's later reference¶ concludes the written history of the species, which thus far includes a description of the

* Forest and Stream, Vol. XXV, No. 23, Dec. 31, 1885, p. 445.

† They are now before me, having been purchased by the American Museum of Natural History.

‡ Forest and Stream, Vol. XXV, No. 25, Jan. 14, 1886, p. 484.

‖ Auk, Vol. III, April, 1886, pp. 275, 276.

¶ Ibid., Vol. III, July, 1886, p. 387.

male bird only, and this based on a single somewhat exceptional example.*

At present the material extant consists of nineteen specimens, all, excepting Mr Stephens's single Sonoran one, collected in Southern Arizona by Mr. Herbert Brown of Tucson, to whom we are indebted for nearly all that is at present known of the species. These specimens are (1) the imperfect female and a few fragments of a male (portions of the breast, tail, and one wing) already mentioned as being in the National Museum at Washington—nominally two specimens; (2) a male and female in the collection of Mr. Manly Hardy, of Brewer, Maine; (3) two males and two

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* The bibliography of the species is at present practically as follows:

1884. [BROWN, HERBERT.] *Ortyx Virginianus* in Arizona. <*Forest and Stream*, Vol. XXII, No. 6, March 6, 1884, p. 104. (From Tucson "Weekly Citizen," date of issue not given.)

A note of eleven lines, announcing the capture of "a pair of genuine Bob White quail....in the Barboquivari range, about sixty miles southwest of Tuscon [=Tucson]."

1884. RIDGWAY, ROBERT. *Ortyx Virginianus* not in Arizona. <*Forest and Stream*, Vol. XXII, No. 7, March 13, 1884, p. 124.

Refers to the note from the Tucson "Weekly Citizen," given in the preceding number of "Forest and Stream." The bird is presumed to be the Massena Quail (*Cyrtonyx massena*), but if not this it is thought that it "must be one of the Mexican species of *Ortyx* (perhaps *O. graysoni*)."

1884. GRINNELL, GEO. BIRD. A Quail new to the United States Fauna. <*Forest and Stream*, Vol. XXII, No. 13, April 24, 1884, p. 243.

Identified as *Ortyx graysoni* by Mr. Robert Ridgway, from "an almost complete skin of a female bird, and portions of the wing, breast and tail of a male," collected by Mr. Herbert Brown and submitted to Mr. Ridgway by Dr. Grinnell. The article gives an account of the range of the species in Arizona, as then known, with notes on its habits.

1885. BREWSTER, WILLIAM. Additional notes on some birds collected in Arizona and the adjoining Province of Sonora, Mexico, by Mr. F. Stephens in 1884; with a description of a new species of *Ortyx* [=*Colinus*]. <*Auk*, Vol. II, April, 1885, pp. 196-200.

Colinus ridgwayi, spec. nov., described (p. 199) from a male taken by Mr. Stephens about eighteen miles southwest of Sasabe, Sonora, Mexico, very near the Arizona boundary. Arizona specimens are reported as having been seen and examined by Mr. Stephens. These, it turns out, were the specimens previously identified by Mr. Ridgway as *Ortyx graysoni*.

1885. BROWN, HERBERT. Arizona Quail notes. <*Forest and Stream*, Vol. XXV, No. 23, Dec. 31, 1885, p. 445.

An article of a column and a half in length, chiefly on *Colinus ridgwayi*, which is announced as the bird previously identified as *Ortyx graysoni* by Mr. Ridgway. A quite detailed account of its habits and distribution is given, with comment on previous records of the species.

1886. RIDGWAY, ROBERT. Arizona Quail. <*Forest and Stream*, Vol. XXV, No. 25, Jan. 14, 1886, p. 484.

Mr. Ridgway does not think "that Mr. Brown has demonstrated the specific identity of *Colinus ridgwayi*, Brewst. and the pair of birds I [he] identified as *Ortyx* (now *Colinus*) *graysoni*, Lawr. To make the matter perfectly clear" he reviews "the history of the subject," and to aid further investigations gives an "artificial key," based on the males, "of the species of *Colinus* found along our southwestern border, including the *C. graysoni*."

1886. ALLEN, J. A. The Masked Bob-white (*Colinus ridgwayi*) in Arizona. <*Auk*, Vol. III, 1886, pp. 275, 276.

Note of half a page in length on Mr. Brown's specimens, described in the present paper.

1886. SCOTT, W. E. D. On the Avi-fauna of Pinal County, with remarks on some Birds of Pima and Gila Counties, Arizona. Part II. <*Auk*, Vol. III, 1886, pp. 383-389.

Short note on *Colinus ridgwayi* at p. 387, referring to Mr. Brown's specimens and observations.

females in the American Museum of Natural History of New York; (4) five males and five females in the collection of Mr. George B. Sennett; and (5) a male, taken in Sonora, Mexico, in the collection of Mr. F. Stephens. All of this material I have had in hand for examination, and nearly all is now before me, and, in addition, a series of nine specimens of *Colinus graysoni*, and several specimens each of *C. coyolcos* and *C. pectoralis*, kindly loaned by the National Museum and Mr. George N. Lawrence. Also about thirty specimens of *C. virginianus texanus*, from Mr. Sennett's collection, collected on the Lower Rio Grande in Texas.*

The species of the genus *Colinus* present a most interesting and puzzling group, consisting of a number of obviously more or less unstable forms, evidently derived, at no very remote period, from some common ancestor. Yet in their extreme phases few congeneric forms present greater diversity of color than is seen, for example, in *Colinus virginianus* on the one hand, with its white head- and throat-markings and barred black and white lower plumage, and *C. coyolcos* on the other, with its wholly black head, neck, and upper breast and uniform deep cinnamon lower parts. Yet there are various stages of intergradation in color, through the intermediate forms *C. graysoni*, *C. ridgwayi*, and *C. pectoralis*, while different individuals of these several transitional forms present a suggestive inconstancy in color-markings. There is practically no decisive difference in any details of form or in size, the individual variation among representatives of either type overlapping any average differences in these features that may be taken as distinctive from their next allied forms; while the females of several of them are not, *inter se*, always certainly distinguishable by any features.

The leading differences presented by the males may be indicated as follows:

A. Throat, forehead, and superciliary stripes *white* bordered with black; the white throat-patch bounded posteriorly by a black collar.

a. Breast brownish red; rest of lower plumage white, with bars and more or less pointed V-shaped marks of black, and with broad streaks of cinnamon on the sides.................. *C. virginianus* and vars.

* It gives me pleasure to acknowledge in this connection my indebtedness to Mr. Ridgway for his kindness in securing to me the use of the material loaned me by the National Museum, and to Messrs. Lawrence, Sennett, and Hardy for the use of the specimens they have very kindly placed at my disposal, since without such assistance the preparation of the present paper would have been impossible.

b. Breast and whole lower plumage uniform cinnamon, with usually distinct touches of black and white on the flanks, and sometimes over the sides and abdomen........... . ...*C. graysoni.*

c. Breast and lower plumage as in *C. graysoni*, with the same tendency to black and white spotting, but the black collar bordering the white throat-patch expanded and covering the breast........*C. pectoralis.*

B. Throat *black;* superciliary stripe and white line on the forehead wanting, or inconstant; sometimes both well-developed; the superciliary stripe generally more or less well defined, or at least distinctly traceable.

a. Black of lower parts confined to the throat and foreneck...*C. ridgwayi.*

b. Black of lower parts extending posteriorly over the whole breast, and the cinnamon tint deepening into chestnut.............*C. coyolcos.*

In respect to the dorsal aspect, the males fall into three groups, in accordance with the amount and depth of the dark tints. Thus in *C. coyolcos* and *C. pectoralis* the blackish tints predominate, as is also the case with highly colored examples of *C. graysoni*, in which the dark tints not only prevail, but are intensified to nearly deep black, and the light markings are reduced to a minimum. *C. ridgwayi* and *C. virginianus texanus*, on the other hand, present the maximum amount of light markings, the creamy white spots and edgings of the scapulars and inner secondaries being the conspicuous feature, while the dark tints are greatly reduced in area and are much less deep in tone, being merely blackish brown. In *C. virginianus* proper the dark markings are coarser and browner than in the last-named forms, and of a more reddish cast of brownish black, while the rufous tints generally are stronger and purer, and the light edging of the inner secondaries is deeper or more tawny. In general effect the dorsal aspect in *C. virginianus* proper is rufous, with a slight cast of glaucous gray, relieved with tawny and blackish brown; in *C. virginianus texanus* and in *C. ridgwayi* it is gray varied with reddish brown, relieved with fine markings of blackish and grayish white, the latter so far prevailing as to give character to the general effect. In *C. coyolcos* and *C. pectoralis*, and in somewhat less degree in *C. graysoni*, the general effect is blackish, relieved with fine touches of white or yellowish-white. In dorsal aspect *C. coyolcos* and *C. pectoralis* are practically indistinguishable, while highly colored specimens of *C. graysoni* are practically similar. On the other hand, light colored examples of *C. graysoni* grade directly into highly colored specimens of *C. ridgwayi*, while the paler examples of the latter grade indistinguishably into Rio Grande specimens of *C. virginianus texanus.* Between this and *C. virginianus* there is the widest gap in the series, through the stronger tone of rufous everywhere prevailing, and the absence of the minutely variegated effect of light and dark tints in *C. virginianus.*

The females of these forms, it is safe to say, cannot be in all cases satisfactorily separated. So far as my present material goes, the female of *C. virginianus* proper differs markedly from the females of all the other forms, it being quite distinct and easily separable with certainty from even the females of *C. virginianus texanus.*

The females of *C. coyolcos* and *C. pectoralis* are practically, and, so far as my material goes, absolutely inseparable, nor can either with certainty be separated from the darker females of *C. graysoni*, while the lighter females of *graysoni* cannot with certainty be distinguished from the females of *C. ridgwayi.* The females of *C. ridgwayi*, again, cannot readily be told from females of *C. virginianus texanus.* There is, however, a slight but quite appreciable average difference between them, easily recognized in comparing a series of each, but of so intangible a character as not to be easily indicated in words. There is also a still stronger average difference between the females of *C. ridgwayi* and *C. graysoni*; as there is also between the females of the latter and those of *C. pectoralis* and *C. coyolcos.*

Although *C. coyolcos* is the smallest of the forms here considered, neither size nor, as will be shown later, any other character can be relied on to distinguish it from *C. pectoralis*, although it may average very appreciably smaller. *C. graysoni* distinctly intergrades in size with *C. ridgwayi*, as shown by the measurements of these two species given beyond, though averaging smaller. *C. ridgwayi*, therefore, is the largest of the forms having uniform cinnamon colored under-parts. It, however, averages smaller than *C. virginianus* (verus), while *C. virginianus floridanus* and *C. v. texanus* correspond in size with *C. pectoralis*, this species and *C. coyolcos* holding about the same relation in respect to size to *C. graysoni* and *C. ridgwayi* that the subspecies of *C. virginianus* do to *virginianus* proper.

The subjoined table of measurements of the wing, tail, and tarsus in the male of these several forms will serve to illustrate these statements as to size. The range of individual variation in these parts will be more fully shown in other tables to be given later.

MEASUREMENTS OF THE WING, TAIL, AND TARSUS OF THE MALE IN SEVEN SPECIES AND SUBSPECIES OF THE GENUS *Colinus*.

Species.	Number of Specimens.		Wing.	Tail.	Tarsus.
C. coyolcos........	2	Largest.	4.10	2.50	1.10
	2	Smallest.	4.00	2.25	1.10
	2	**Average.**	**4.05**	**2.38**	**1.10**
C. pectoralis	2	Largest.	4.65	2 65	1.15
	2	Smallest.	3.75	2.27	1.00
	2	**Average.**	**4.20**	**2.46**	**1.08**
C. graysoni.......	6	Largest.	4.45	2.90	1.25
	6	Smallest.	4.20	2.45	1.10
	6	**Average.**	**4.31**	**2.72**	**1.16**
C. ridgwayi.......	8	Largest.	4.65	3.00	1.25
	8	Smallest.	4.35	2.65	1.15
	8	**Average.**	**4.45**	**2.84**	**1.20**
C. virginianus.....	7	Largest.	4.60	3.00	
	7	Smallest.	4.37	2.55	
	7	**Average.**	**4.47**	**2.82**	
C. floridanus......	16	Largest.	4.50	3.00	
	16	Smallest.	4.00	2.30	
	16	**Average.**	**4.22**	**2.52**	
C. texanus........	10	Largest.	4.45	2.75	1.20
	10	Smallest.	4.00	2.25	1.10
	10	**Average.**	**4.17**	**2.51**	**1.14**

Colinus ridgwayi. MASKED BOB-WHITE.

(PLATE XXIII.)

Ortyx virginianus [BROWN], Forest and Stream, XXII, No. 6, 1884, 104. (First published notice of the species.)

Ortyx graysoni GRINNELL (*ex* RIDGWAY), Forest and Stream, XXII, No. 13, Apr. 24, 1884, 243. (First identified as *O. graysoni.*)

Colinus graysoni RIDGWAY, Forest and Stream, XXV, No. 25, Jan. 14, 1886, 484.—A. O. U. Check List N. A. Birds, 1886, 168.

Colinus ridgwayi BREWSTER, Auk, II, April, 1885, 199.—BROWN, Forest and Stream, XXV, No. 23, Dec. 31, 1885, 445.—A. O. U. Check List N. A. Birds, 1886, 168.—ALLEN, Auk, III, April, 1886, 275.—SCOTT, ibid., July, 1886, 387.

DESCRIPTION.—*Adult Male.*—Front part of head, sides of head and neck, and throat black, with or without a narrow white frontal line and white superciliary stripes, which are sometimes well-defined and conspicuous, but usually more or less obsolete, with little or no white in front of the eyes (rarely wholly wanting); lower parts cinnamon, varying in different specimens from pale cinnamon to very deep cinnamon, generally unspotted except on the flanks and crissum, which are sometimes almost immaculate, but the flank feathers are usually distinctly tipped with an oval spot of white, preceded by a subterminal bar of black, and the lower tail-coverts have a V-shaped spot of black, broadly bordered with whitish; occasionally there are small touches of black and white along the sides; crown, hind-head, and nape mixed black, white, and pale brown, the latter frequently varying to yellowish-white; hind-neck and interscapulars reddish-brown, slightly darker than the color of the breast, with usually a slight grayish or glaucous cast; back, rump, and upper tail-coverts minutely variegated with blackish, pale brown, and grayish-white, the black usually prevailing, and varying in amount in different specimens; wing-coverts rufous (varying greatly in intensity in different specimens), each feather barred with blackish and edged and tipped more or less broadly with grayish- or yellowish-white; primaries blackish-brown, edged and scalloped externally with whitish; secondaries externally blackish-brown, barred and freckled with pale brown and yellowish-white; scapulars and "tertiaries" (including the innermost secondaries) edged with yellowish-white (very broadly so on the inner edge), and variegated with deep blackish-brown, pale rufous, and yellowish-gray, the black prevailing; tail above bluish-gray, minutely freckled and waved, particularly toward the tip, with grayish-white, varying to yellowish-white; tail below gray, faintly and irregularly barred and waved with grayish-white; bill deep black, extreme tip sometimes lighter; legs and feet horn color, darkest on the feet; "iris brown." Length,* 9,75 inches; extent,* 14,34; wing,† 4,45; tail, 2,70; tarsus, 1,20.

Adult Female.—Above as in the male, but generally somewhat lighter or grayer, but the darker colored females are indistinguishable above from the very pale males; broad superciliary stripes, meeting on the forehead, and the throat yellowish-white, usually uniform over the whole throat, but sometimes lightening on the central and upper part to nearly pure white; a narrow, not well defined collar of black spots bordering the white throat patch posteriorly; breast rufous, lightening to cinnamon on the sides and flanks, the breast marked with small spots of black and soiled white, and the sides and flanks with coarse V-shaped marks of black, and terminal elongated spots of white; lower breast and abdomen soiled grayish- or buffy-white, each feather barred subterminally with black, the bar V-shaped or pointed in the middle, and behind it, especially centrally, a narrow bar of rufous; in some specimens the black bars are nearly transverse, lacking the V-shaped point.‡ Bill, feet, and iris as in the male. Length,‖ 9,66; extent,‖ 14,40; wing,¶ 4,39; tail, 2,81; tarsus, 1,16. The female averages very slightly smaller in measurements than the male, but appears to slightly exceed the male in weight. Thus Mr. Brown, in a letter of March 30, 1886, gives the weights of ten specimens, five males and five females, with the entrails removed, as follows: males, two four ounces each, one four and a half, and two five ounces each; females, one four and a half, one four and three-quarters, one five, one five and a half, and one six. The females thus average one-fourth of an ounce *heavier* than the males.

The color of the lower parts in the male is very similar to that of the same parts in the common Robin (*Merula migratoria*), and varies similarly, but rather more, in intensity in different indi-

* Collector's measurements; average of six specimens.

† Measurements of wing, tail, and tarsus from skins; average of nine specimens.

‡ Of the six females before me as I write three have the bars transverse, while in the other three they are more or less V-shaped in the middle—as much so as in average *C. virginianus texanus*, or as in the females of *C. graysoni.*

‖ Collector's measurements; average of seven specimens.

¶ Measurements of wing, tail, and tarsus from skins; average of seven specimens.

viduals, perhaps with age. But the most conspicuous variation is in the white markings of the head. These are sometimes wholly wanting, as in the Sonoran specimen described by Mr. Brewster. In others, as in one of the males before me, there is no white on the forehead or in front of the eye, but there are slight touches of white behind the eye, which become so numerous from a point above the ear and thence posteriorly as to be barely suggestive of a stripe. In another example, there are a few touches of white above the eye, and a white postocular stripe, which becomes quite broad where it terminates on the side of the neck. Three other specimens are similarly marked with a lateral head stripe extending as far forward as the eye—in one of them as far as the front border of the eye. Two specimens have well-defined but rather narrow white superciliary stripes running from the nape to the nostrils. What is still further suggestive of a close relationship to *C. graysoni* is the presence of touches of white on the throat in nearly every specimen, varying from the merest touch on a very few feathers in some examples to well-defined and quite conspicuous blotches in others. The material now at hand merely shows indications of intergradation with that species. Exploration of the considerable portion of Northern Mexico which separates the localities whence comes the material now in hand, representing these two forms, may show that they are merely geographical extremes of a single species. Such a result, to say the least, would certainly not be surprising. The chief difference between the two forms is the slightly larger average size of *C. ridgwayi*, its rather paler colors (as would be expected, respectively, from its more northern and more desert habitat), and black instead of white throat, and the tendency to absence of white frontal and superciliary stripes.

The amount of spotting on the flanks and the lower tail-coverts varies greatly in different specimens, in some the spots being reduced to a few slight touches of black and white on the flanks, and on the coverts to mere shaft-lines of black and obsolete touches of white; in other specimens the spots on the flanks are numerous and large, while the lower tail-coverts are marked conspicuously with black and white, the longer middle feathers being sometimes crossed with a series of V-shaped black bars, separated by white. In some of the specimens which have the flanks coarsely spotted the lower tail-coverts are almost immaculate, having but the slightest indications of either black or white touches. In short, each specimen may be said to differ very considerably in details of color-markings from all the others, as is found to be the case also in *C. graysoni.* The spotting on the flanks, and the general color beneath in the darker specimens, and also the markings on the lower tail-coverts, it may be added, are precisely the same as in *C. graysoni*, and equally inconstant.

The females, *inter se*, vary much less than the males, the chief differences being in the intensity of the tints. Several of the females, however, show slight touches of black in the cream-colored throat-patch, one being quite conspicuously thus freckled with black, while another has the greater part of the throat-patch solid black. (See Plate XXIII, lower right hand figure.) This may be merely an old female taking on male characters, as sometimes happens among the Gallinæ, but there is no other feature indicative of such a change, or of very old age; hence this may indicate merely the unstable character of the form, in respect especially to the white and black head- and throat-markings.

As already said, the females of *C. ridgwayi* are not certainly distinguishable from the females of either *C. graysoni* or *C. virginianus texanus*, particularly the latter. There are specimens of the latter in Mr. Sennett's collection that are absolutely indistinguishable from females of *C. ridgwayi* except by the labels, without which it would be impossible to say with certainty whether they came from the Lower Rio Grande region of Texas or from Arizona. Generally the female of *C. ridgwayi* shows more rufous and less black on the breast, but this is by no means uniformly the case, the average difference in this respect being slight. Yet the males of these two forms show no tendency to intergradation.

The subjoined tables indicate the range of variation of *C. ridgwayi* in measurements, and its comparative dimensions as compared with a similar series of *C. graysoni* and *C. virginianus texanus*, both of which, it will be seen, average somewhat smaller than *C. ridgwayi.*

MEASUREMENTS OF SIXTEEN SPECIMENS OF *Colinus ridgwayi*.

Collection.	Sex and age.	Locality.	Date.	Collector.	Length*	Extent*	Wing.	Tail.	Tarsus.
G. B. Sennett.......	♂ ad.	Barboquivari Mountains, Arizona.......	Sept. 28, 1885.	Herbert Brown.	....	.....	4.55	2.85	1.28
Am. Mus. Nat. Hist.	♂ ad.	" " "	" 28, 1885.	" "	....	.....	4.45	2.70	1.20
" "	♂ ad.	" " "	" 27, 1885.	" "	...	.....	4.65	2.80	1.25
G. B. Sennett.......	♂ ad.	" " "	Feb. 4, 1886.	" "	9.50	14.20	4.40	2.65†	1.15
" "	♂ ad.	" " "	" 5, 1886.	" "	9.50	14.12	4.35	2.85	1.15
" "	♂ ad.	" " "	" 8, 1886.	" "	9.75	14.12	4.40	3.00	1.20
" "	♂ ad.	" " "	" 8, 1886.	" "	9.75	14.50	4.35	3.00	1.20
M. Hardy...........	♂ ad.	" " "	" 8, 1886.	" "	10.30	14.60	4.45	2.80	1.20
F. Stephens.....	♂ ad.	Sasabe, Sonora, Mexico................	Aug. 11, 1884.	F. Stephens.	9.70	14.50	4.45	2.75	1.20
Am. Mus. Nat. Hist.	♀ ad.	Barboquivari Mountains, Arizona.......	Feb. 4, 1886.	Herbert Brown.	9.60	14.20	4.50	2.80	1.15
" "	♀ ad.	" " "	" 8, 1886.	" "	9.50	14.15	4.25	2.80	1.15
G. B. Sennett.......	♀ ad.	" " "	" 8, 1886.	" "	9.50	14.75	4.50	2.90	1.12
" "	♀ ad.	" " "	" 8, 1886.	" "	9.75	14.60	4.40	2.87	1.20
" "	♀ ad.	" " "	" 8, 1886.	" "	9.75	14.50	4.45	2.82	1.15
" "	♀ ad.	" " "	" 12, 1886.	" "	9.75	14.40	4.25	2.75	1.20
" "	♀ ad.	" " "	" 12, 1886.	" "	9.80	14.50	4.45	2.80	1.15
M. Hardy.	♀ ad.	" " "	" 4. 1885.	" "	9.75	14.25	4.25	2.75	1.12

* Collector's measurements from fresh specimens. † Tail imperfect.

MEASUREMENTS OF NINE SPECIMENS OF *Colinus graysoni.*

National Museum Number.	Collector's Number.	Sex and age.	Locality.	Date.	Collector.	Wing.	Tail.	Tarsus.
50888*	500	♂ ad.	Near Guadalajara, Mexico........	....	Col. A. J. Grayson.	4.35	2.45	1.20
81926	...	♂ ad.	Guanajuato, Mexico.......	....	Prof. A. Dugès.	4.20	2.90	1.25
81927	...	♂ ad.	" "	....	" "	4.45	2.90	1.10
78092	...	♂ ad.	Jupataro, Guanajuato, Mexico..	... .	" "	4.35	2.75	1.12
105478	...	♂ ad.	Moro Leon, " "	....	" "	4.20	2.60	1.12
85970	...	♂ ad.	Tupataro, Mexico........................	....	" "	4.63	2.75	1.20
52766	502	♀ ad.	Guadalajara, Mexico	....	Col. A. J. Grayson.	4.37	2.55	1.25
42568	501	♀ ad.	" "	....	" "	4.30	2.60	1.20
78091	...	♀ ad.	Jupataro, Guanajuato, Mexico	....	Prof. A. Dugès.	4.40	2.75	1.25

* Collection of Mr. George N. Lawrence.

MEASUREMENTS OF SEVENTEEN SPECIMENS OF *Colinus virginianus texanus.*

Collection of G. B. Sennett.	Sex and Age.	Locality.	Date.	Collector.	Extent†	Length†	Wing.	Tail.	Tarsus.
853	♂ ad.	Hidalgo, Texas	May 8, 1877.	G. B. Sennett.	9.50	14.65	4.30	2.62	1.16
480	♂ ad.	Lomita, "	" 15, 1878.	" "	9.25	13.75	4.12	2.60	1.10
1875	♂ ad.	" "	July 22, 1880.	M. A. Frazar.	....	.....	4.12	2.55	1.12
1389	♂ ad.	" "	" 28, 1880.	" "	....	.....	4.00	2.45	1.12
1455	♂ ad.	" "	Aug. 16, 1880.	" "	...	.....	4.00	2.37	1.12
1488	♂ ad.	" "	" 24, 1880.	" "	....	.....	4.25	2.50	1.12
1489	♂ ad.	" "	" 26, 1880.	" "	...	.....	4.10	2.25	1.15
1490	♂ ad.	" "	" 26, 1880.	" "	....	.....	4.20	2.35	1.15
1510	♂ ad.	Santa Maria, Texas	Sept. 22, 1880.	" "	...	.....	4.15	2.70	1.20
1868	♂ ad.	Point Isabel, "	Mch. 2, 1881.	" "	....	.....	4.45	2.75	1.20
208*	♀ ad.	Nueva Leon, Mexico	May, 1853.	Lieut. D. N. Couch.	9.00	13.75	4.12	2.50	1.15
98	♀ ad.	Brownsville, Texas	Mch. 27, 1877.	G. B. Sennett.	9.00	14.25	4.12	2.60	1.19
140	♀ ad.	Lomita, "	April 19, 1878.	" "	9.50	14.50	4.17	2.45	1.18
852	♀ ad.	Hidalgo, "	May 3, 1877.	" "	9.50	14.25	4.05	2.85	1.05
1511	♀ ad.	Santa Maria, "	Sept. 22, 1880.	M. A. Frazar.	....	.....	4.00	2.45	1.10
1512	♀ ad.	" "	" 22, 1880.	" "	....	.....	4.35	2.65	1.18
1518	♀ ad.	" "	" 22, 1880.	" "	....	.....	4.05	2.60	1.25

* Collection of Mr. George N. Lawrence. † Collector's measurements from fresh specimens.

Habits and Distribution.—According to Mr. Brown, to whom we are indebted for nearly all we as yet know on these points, the Arizona Bob-white has a restricted distribution in Arizona, where it is limited to the southern border of the Territory. It is doubtless properly a Mexican species, which extends northward for only a short distance beyond the Arizona line, and southward into Mexico for an unknown distance, where possibly—we may almost say probably—it merges into *C. graysoni.* The only Mexican specimen at present known is the one already repeatedly cited as taken in Sonora, about ten miles south of the Arizona line.

According to Mr. Brown, the Arizona Bob-white has long been known "to every old time resident of Southern Arizona," by whom it was supposed to be the same as the well-known Bob-white (*C. virginianus*) of the Eastern States.* He gives its habitat as "the country lying between the Barboquivari range in Arizona and the Gulf coast in Sonora, and more especially between the Barboquivari and Plumosa, [where] this species is quite abundant. ....The 'hooded quail' (*Colinus ridgwayi*) was, three years since [in 1882], abundant in the neighborhood of Bolle's Well, a stage station on the Quijotoa road, near the northern end of the Barboquivari range, twenty-nine miles southwest of Tucson, and about forty miles north of the Mexican boundary line. As the station was then comparatively new, the grass thereabouts was high, and these quails could be had for the taking; but now that stock has eaten away the grass, the birds have not, for a year or more, been seen about the place.

" On the road from Bolle's Well west to the Coyote range (about twenty-five miles), these quails were frequently to be met with, but teamsters and travelers have killed or frightened them off. One of the former assured me that he had killed as many as five at one shot. Ten miles south of Bolle's, in the Altar Valley, we came across a small covey—there were, perhaps, a dozen in all. The bright, deep chestnut breast plumage of the males looked red in the sun, and gave the birds a most magnificent appearance. We secured but one, a male, the rest secreting themselves in the

* Forest and Stream, Vol. XXII, No. 6, March 6, 1884, p. 104; ibid., Vol. XXV, No. 23, Dec. 31, 1885, 445.

tall sacaton grass, which at this point was between four and five feet high, and as we had no dog we did not follow them in. Our next place to find them was on the mesa southeast of the [Barboquivari] Peak, where we camped to hunt for them, but they were scarce, and we managed to secure but few....

"The base of the Barboquivari range is at intervals broken into immense canyons, which lie at right angles with the main body of the mountain, and stretch far to the plains below. For a mile or more after leaving the base proper, they are filled with an almost impenetrable growth of underbrush, weeds and grass. Lower down, however, they flatten out and largely lose their canyon characteristics, but seldom sufficiently so to be the feeding ground of *Colinus ridgwayi*. To determine this point we worked these canyons for two consecutive days in vain, inasmuch as we failed to see or hear one, other than those on the intervening mesas."*

In a letter dated Feb. 9, 1886, Mr. Brown writes me that the collectors whom he had sent out especially for these birds reported to him as "having found but one small flock in a tramp of four days, and out of it they succeeded in getting the five [sent at this date]. This was in the Altar Valley." In a later letter (date of April 24, 1886), Mr. Brown states that the Quails he sent me "were taken at least eighteen miles north of the Sonora line.... Thirty-three or thirty-five miles is the farthest north of the line that I have ever known this Quail."

In respect to habits, Mr. Brown, in his "Forest and Stream" articles already cited, says that, so far as he knows them, "they appear to resemble very closely those of the common quail [*C. virginianus*], only slightly modified by the conditions of their environment. They utter the characteristic call, 'Bob White,' with bold, full notes, and perch on rocks and bushes when calling. They do not appear to be at all a mountain bird, but live on the mesa, in the valleys, and possibly in the foothills....In addition to their 'Bob White' they have a second call of *hoo-we*, articulated and as clean cut as their Bob White. This call of *hoo-we* they use when scattered, and more especially do they use it when separated toward nightfall. At this hour I noted that, although they occasionally called 'Bob White' they never repeated the

* Forest and Stream, Vol. XXV, No. 23, Dec. 31, 1885, p. 445.

first syllable, as in the day time they now and then attempted to do.... I will venture to say that when frightened and scattered they are a hard bird to get. Hear one call, locate it as you may, see one fly and mark it down, and without a dog it is virtually impossible to flush it."

The specimens taken the last of September had not completed their moult.

Mr. Brown describes their food as consisting of berries, seeds, succulent leaves of plants, and insects, the latter including grasshoppers and various species of small beetles, from minute ones to a curculio half an inch long, and an hemipterous insect of about the same size. The seeds are of various species of plants, a coarse seed of cylindrical form prevailing, as shown by the stomachs of ten specimens kindly sent me by Mr. Brown for examination.

NOTE ON *Colinus pectoralis* AND *C. coyolcos* AND THEIR RELATIONS TO *C. graysoni* AND *C. ridgwayi*.—In size and coloration *Colinus pectoralis* and *C. graysoni* are closely related,* the only difference of importance being the expansion of the frontal black collar from a narrow band of usually less than half an inch in width in *C. graysoni* to a broad patch an inch and a half or more in width, and covering nearly the whole breast, in *C. pectoralis*. It is not distinguishable likewise from *C. coyolcos* in either size† or coloration, except that in the extreme phase of the latter the white head- and throat-markings are entirely replaced by black, as in the specimen from Mr. Lawrence's collection. Another specimen (Nat. Mus. No. 58,923), however, has quite broad white superciliary stripes which meet on the forehead, and also a patch of white on each side of the throat below the auriculars, and a slight flecking of white over the whole throat. In short, this example is exactly intermediate between ordinary *pectoralis* and highly developed *coyolcos*, so exactly combining the characters of the two that it might be looked upon as a bybrid between them.

* I have before me two adult males of *C. pectoralis*, in one (Nat. Mus. No. 28,058, Mirador) of which the wing measures only 3.75 inches—less by .20 than my smallest example of *C. coyolcos*—while in the other (Coll. G. N. Lawrence, City of Mexico), the wing measures 4.65, or .20 more than the longest wing in a series of six males of *C. graysoni!*

† The two male examples of *C. coyolcos* before me are intermediate in size between the two examples of *C. pectoralis* cited in the last foot-note, the wing of one (Nat. Mus. No. 58,928, Tehuantepec) measuring 4.00, and the wing of the other (Coll. G. N. Lawrence, Tehuantepec) 4.10. A female (Nat. Mus. 57,877), labeled "*Ortyx coyolcos* ♀," Tehuantepec, has a wing measuring 4.25!

Another specimen (Nat. Mus. No. 57,876), labeled "*Ortyx coyolcos* ♀ juv." (a very small example with the wing only 3.87, and evidently a young bird), has a cream-colored throat-patch and superciliary stripes, with the black forming a narrow collar, much as in *C. graysoni*, but with a few black feathers also in the throat-patch. The specimen is still partly in first or nestling plumage, and may not be full-grown.

While it would not be wise to generalize dogmatically from the scanty materials now at hand, it may be safe to say that they seem to indicate the instability and probable complete integradation of *C. coyolcos* and *C. pectoralis*, not only *inter se* but with *C. graysoni;* and, as already indicated, the latter is most likely to be found to intergrade with *C. ridgwayi* in the unexplored region at present separating the known habitats of the two. My own conclusions therefore coincide very closely with those of Mr. Ridgway, already published,* namely, that "*C. coyolcos* and *C. pectoralis* may be individual color phases of one species (*C. coyolcos*), and that *C. graysoni* and *C. ridgwayi* bear the same relation to one another."

* Forest and Stream, Vol. XXV, No. 25, Jan. 14, 1886, p. 484, foot-note.

ADDITIONS AND CORRECTIONS.

Page 209, line 2, for NICHOLAS read NICOLAS.

" 213, " 3, for NICHOLAS read NICOLAS.

" 225, under [14.] **Megalestris skua,** change lines two and three of this paragraph to read as follows: The only records are George's Banks, July, 1878 (*Brewer*, Bull. Nutt. Orn. Club, III, 1878, 188); Polluck Rip, off Cape Cod, Sept. 10, 1884 (*Goss*, Auk, I, 1884, 394).

" 240, line 12, for May 25 read May 20.

" 241, " 18 (under [147*a*.] **Œgialitis meloda circumcincta**) add: There are two specimens (male and female) of this variety in the Museum of the College of Princeton, taken by Mr. W. E. D. Scott, at Long Beach, Barnegat Bay, N. J., in April, 1877. In the same collection are also two specimens taken near Portland, Me., by Mr. N. C. Brown, respectively May 17, 1878 and May 2, 1880. None of these specimens appear to have been previously recorded.

" 241, line 26, for 151 read *151.

" 243, " 33, for Dec. 1869 read Jan. 1870, 568.

" 244, " 24, for 174 read *174.

" 244, " 27, for 175 read *175.

" 244, " 36, for VI read V.

" 246, " 1, for 1869 read 1870.

" 247, " 5, for 1869 read 1870.

" 250, " 30, for 233 read *233; and after "Marked as breeding by Dr. Emmons," add: and its nest was found in Cambridge in May, 1859 (*Brewer*, Hist. N. Am. Bds, I, 1874, 482). This nest is in the Museum of Comparative Zoölogy, Cambridge.

" 251, line 28, insert Mr. Purdie has recorded it as breeding at Saybrook, Conn. (Am. Nat., VII, 1873, 692).

" 256, line 4, insert, before the word *Woolsey*, *Purdie*, Am. Nat., VII, 1873, 692.

" 256, line 13, after the word see insert: *Purdie*, Am. Nat., VII, 1873, 692.

" 258, " 28, for 557 read 577.

" 268, " 13, for 259 read 289.

" 276, " 4, for Mr. F. Stephens read the British Museum.

POSTSCRIPT.—The distribution of the present number of the Bulletin has been delayed for six weeks, in consequence of unexpected and unavoidable delay in the printing of the plate which accompanies it. Separates of the first four articles were delivered to the authors, and to some extent by them distributed, during the first week of August.—J. A. A., Sept. 1, 1886.

ARTICLE XVII.—*Notice of Geological investigations along the Eastern shore of Lake Champlain, conducted by Prof. H. M. Seely and Prest. Ezra Brainerd, of Middlebury College, with descriptions of the new Fossils discovered.* By R. P. WHITFIELD.

There are some of the formations of the New York Geological series which have thus far furnished but few fossil remains wherewith to identify them at localities other than the original ones studied. Among these the Birdseye limestone has been somewhat conspicuous. At the few localities where it was originally studied, it had been recognized largely from its lithological features, stratigraphical relations, and two peculiar plant-like organisms, which by the weathering of their ends on the horizontal surfaces of the rock, produces the peculiar feature which gives it the name Birdseye. This feature, however, is not always present, neither do the lithological features always hold good, or the stratigraphical relations prove clear; so that the want of fossil remains proves to be something of a drawback in studying its relations. If we examine Vol. 1 of the New York Palæontology for its peculiar and characteristic fossil remains, we find only fifteen species in all. These are *Phytopsis tubulosum* and *P. cellulosum*, Hall, the two plant remains mentioned above, one Lamellibranchiate of doubtful character; nine Gasteropods; two Cephalopods; and one Crustacean of undetermined relations. Besides these there is one Sponge; two Corals; two Bryozoans and one Gasteropod, *Trochonema umbilicatum*, Hall, which are also common to the Black River, or to the Trenton limestone above. Most of the specimens of these species originally figured were poorly preserved and very unsatisfactory. Hence, we may consider that any addition to the fauna of this bed would be of importance, and materially aid in their study. For this reason I have considered it of importance to science that the new forms herein described should be published.

During the past year, Prof. H. M. Seely and Prest. Brainerd, with several other members of the Faculty of Middlebury College, Middlebury, Vt., have undertaken the very praiseworthy task of working out more in detail the geological structure of the Vermont border of Lake Champlain and its islands, in the progress

[*Dec. 28th*, 1886.]

of which they have obtained from a very restricted locality on the lake shore, a few miles from Vergennes, Vt., a group of fossils which they have placed in my hands for description. The locality had been known to consist of the Chazy, Birdseye and Black River limestones, recognized principally from stratigraphical evidence, and from the occurrence of Chazy fossils in the lower beds, while the upper beds had not afforded Palæontological evidence to any amount heretofore. The particular bed which I have here referred to the Birdseye limestone has yielded to these gentlemen so far, five Brachiopods; sixteen Gasteropods; twelve Cephalopods and one variety; two Trilobites and two bivalve Crustaceans; thirty-seven species and one variety, all in a recognizable condition, and are here illustrated. All but five of these are new to science; of the others, four are identical with forms originally described from the Quebec group of the Canadian Geol. Survey, or from their Calciferous (probably not the Calciferous of the New York Palæontology). The other one is *Asaphus canalis*, Con., of the New York Palæont., never before fully recognized or illustrated. Besides these, there are *Maclurea affinis*, Billings, and *M. Logani*, Salter; also a *Murchisonia*, closely resembling, if not identical with, *M. cicelia*, Billings, and several undeterminable Gasteropods. *Orthoceras bilineatum*, Hall, is quite common, and there are at least two other *Orthoceras* which are too poor for illustration; also three apparently undescribed trilobites and a species of Harpes closely resembling *H. Ottawaensis*, Bill.; but after strict comparison with an electrotype of the original I think can scarcely be identical. These undetermined forms are too poor for description and illustration, and must wait until better material is obtained.

Of the previously known forms from this locality:
Orthis Evadne, Billings?
Hemipronites apicalis, Bill.,
Maclurea affinis, Bill.,
Pleurotomaria Etna, Bill., and
Murchisonia cicelia, Bill., were originally referred to the Quebec by Mr. Billings, and
Holopea arenaria, Bill.,
Triblidium simplex, Bill., to the Calciferous sandstone, while

Maclurea Logani, Salter,

Orthoceras bilineatum, Hall, and

Asaphus canalis, Conrad, are from the Birdseye limestone, and the latter also from the Chazy limestone. The Quebec group beds, in which the five species above named occur are undoubtedly Birdseye or Birdseye and Black River limestones ; and the formation in which the two occur, which are referred to the Calciferous sandstone, certainly cannot be Palæontologically identical with the Calciferous of New York. Considering the evidence furnished by these fossils, and the great prevalence of gasteropods and coiled cephalopods, I should consider the beds as undoubtedly of the age of the Birdseye limestones of other parts of the State. Prof. Henry M. Seely has been much inclined to place them with the Chazy limestone; but so far as I can determine there is not a single fully characteristic Chazy fossil in the entire assemblage.

There is yet an uncertainty as to where the limits between the Chazy limestone and the Birdseye should be drawn. In the true Chazy, as recognized in the Palæontology of New York, there is a peculiar group of Gasteropods, *Scalites*, and its congeners, which have so far, at least to my knowledge, never been found in any other bed. But *Maclurea* runs up and through the Trenton, so cannot be considered a strictly characteristic form of the Chazy, and as none of the Scalites-like forms are found in this bed, although only thirty feet or so above the recognized Chazy, I see no reason, Palæontologically at least, for considering it as Chazy. The bed in which these fossils occur is about twenty feet above the layer in which the gasteropod *Calaurops* occurs so abundantly, which if projected across the bay to the point north of Fort Cassin, would overlie the Chazy limestone which crops out there, and is filled with *Maclurea magna*. The *Calaurops* layer I suppose to be Chazy limestone, and is a tough, heavy-bedded limestone greatly resembling the Maclurea bed.

The following geological sketch of the locality and its surroundings, with the accompanying geological map, has been furnished by the parties making the survey, who are also responsible for the geological conclusions. Although I visited with them Fort Cassin and some of the points along the lake shore in August last, I did not see the rocks on the south shore of Field's Bay, the fossils from which are quite unsatisfactory.

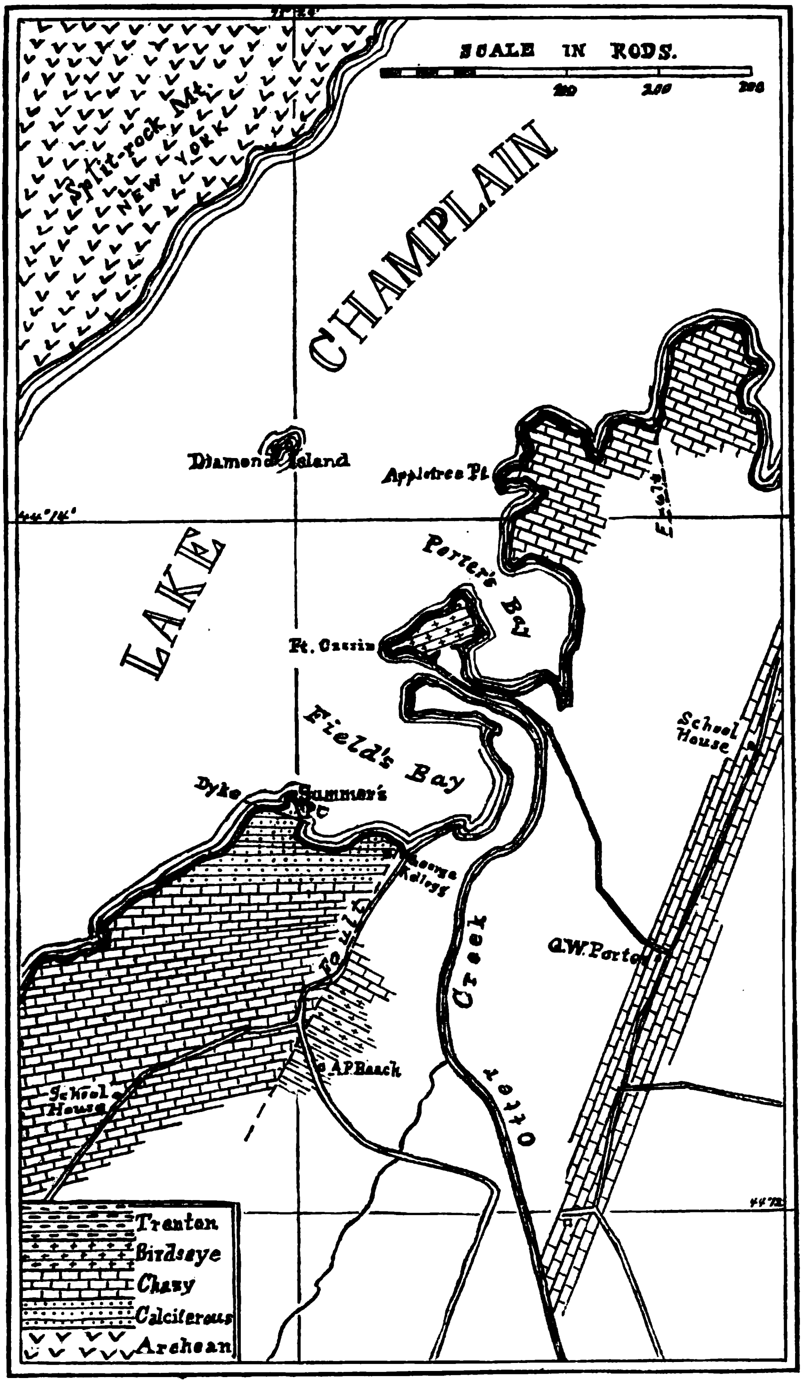
An Account of the Rocks at Fort Cassin and Vicinity.

Fort Cassin consisted chiefly of earthworks, erected by Lieut. Cassin at the mouth of Otter Creek during the war of 1812. On the very site of the fort has recently been discovered the remarkable group of fossils described in the accompanying paper.

The promontory, on the west end of which the fort is situated, seems to have been once a rocky island, now connected with the mainland by the alluvial deposits of the river. The strike of the strata on the northeast side is N. 87½° E. by the magnetic needle, the declination of which at this place, at the present time, is 12° W. The strike varies gradually until it becomes N. 80° E. at the southwest end. The dip is from 6° to 8° southerly. The fossils are for the most part from an upper stratum, which forms about two-thirds of the surface. On the north shore are disclosed 15 or 20 feet of lower strata.

The strata vary much in their lithological character. Near the top occurs a bed, one or two feet in thickness, of yellowish-weathering dolomite. The stratum from which most of the fossils were obtained is a pure, fine-grained, compact limestone. A few years since a persistent but unsuccessful attempt was made to manufacture hydraulic cement from the rock of these upper strata. The large building and the kilns built for this purpose are still standing on the south side of the promontory. The middle strata are thin bedded and shaly, and on the northwest side have been worn out by the action of the waves, forming in one place a grotto whose roof is supported by natural columns of the shaly rock. Beneath this are thicker strata of tough, somewhat impure limestone, in which the new genus *Calaurops* was discovered. And lowest of all, at the most northerly point, is a thick bed of sandy limestone weathering on the edges in prominent ridges about one inch in width.

Three hundred rods south of the fort, on the south shore of Field's Bay, occur massive beds of tough dolomite, dipping S. 11° W. > 5° at George Kellogg's house, and S. 33° W. > 8° at



GEOLOGICAL MAP OF FORT CASSIN, VT., AND VICINITY.

Summer's Point. A dike, eight feet in width, of reddish porphyritic trap, extends across the base of Summer's Point. Farther south along the shore are seen higher strata of shale and impure limestone, the latter containing in abundance *Orthis costalis* and other fossils characteristic of the lower Chazy formation. At the bay, three-fourths of a mile south of Summer's Point, the massive beds of the Chazy containing *Maclurea magna* are first seen. Still farther south, higher and higher strata of this latter formation occur, the strike curving more and more to the south, until at Button Bay Island the Black River limestones are reached. The Maclurea beds extend eastward from the shore in high ridges for two or three hundred rods, terminating suddenly in a fault, which runs from near George Kellogg's house southerly through a point near the forks of the road. To the east of this fault the strata have a high dip to the southwest, and consist of the Chazy, Black River and Trenton rocks in succession. The dolomitic rocks on the south shore of Field's Bay are believed to be Calciferous on account of their position beneath the Chazy, their lithological character, and the occurrence of obscure fossils, which resemble *Ophileta* and *Murchisonia Anna*, of Billings. A necessary inference is, that beneath the waters of Field's Bay there is either a fault running east and west, or an abrupt fold, bringing up the lower rock to the south.

The headland north of Porter's Bay, however, seems to be connected without a break with the Fort Cassin rock. It is composed of Chazy rock, of which over 300 feet in thickness is exposed. The dip is quite uniformly 8½° to the southwest. On the north shore of the headland the strike is N. 45° W., and the shaly layers and the fossils of the Lower Chazy are abundant. On the south shore the strike is N. 56° W., and the rock and the fossils are like those seen in neighboring exposures at the top of the Chazy. At the extreme southwest point and at Appletree Point, the strata are curved rapidly to the south, having a strike of S. 50° W., which, continued across the mouth of Porter's Bay, would bring these strata just beneath that of Fort Cassin.

The most northern promontory on the map appears to be separated from the one just described by a fault. The dip is S. 33°

W. > 9½; and the rock at the northern point consists of the same shaly layers already described as at the base of the Chazy.

Still farther to the northeast are promontories not represented on the map, consisting mainly of Chazy rock, but in part also of the Calciferous and Black River. These, however, bear evidence of much greater disturbance. The strata are often abruptly folded; several faults occur; and the rock is frequently intersected with dikes of trap.

But a mile to the east of Fort Cassin occurs an uplift, which is more characteristic of the geology of the western part of Addison County. By a longitudinal fault, extending several miles in nearly a straight line, the older formations are brought up on the east side and thrust over on to the newer formations on the west. The uplift represented on the map consists of the upper strata of the Chazy, dipping on the average S. 55° E. > 7°. To the south of Mr. G. W. Porter's house occur higher strata, which appear to belong to the base of the Birdseye formation. This uplift, after a short interval, may be traced in the same line for four or five miles to the south of Otter Creek; and in this part of the monoclinal there are extensive exposures of the Black River strata. To the east of this long ridge is a wide valley covered for the most part with Champlain clays, but showing now and then hillocks of Trenton limestone or of Utica slate. On the east side of the valley occurs another monoclinal uplift, in which the massive limestones of the Lower Silurian are seen overriding the slates, especially at the Falls of Vergennes and at Ferrisburgh Center. This is the fault whose appearance seven miles south of Vergennes is described by Prof. Emmons in the Geology of New York, Pt. II, pp. 280, 281. Still farther east is seen "the great break," in which the rocks of the Potsdam Period are lifted up in some places a thousand feet above sea level, and form a series of hills stretching from Snake Mountain north into Canada.

The rocks along the shore, in the vicinity of Fort Cassin, seem to have been subjected to a more irregular disturbance, on account of their nearness to the Archæan terrane, which even now rises abruptly on the west shore of the lake. The waters of the lake here attain to their greatest depth of nearly 400 feet. Wedged in between the firm mountain wall of the ancient shore and the moving mass of thicker strata on the east, it is not surprising that the rocks under discussion should have been profoundly folded and fractured.

MOLLUSCOIDEA.*

BRACHIOPODA.

Genus ORTHIS, *Dalman.*

Orthis Evadne, Billings?

PLATE 24, FIG. 8.

Orthis evadne, Billings; Pal. Foss. Canada, Vol. 1, p. 79, fig. 74.

A single valve somewhat smaller than the figure given by Mr. Billings in his Pal. Foss., Vol. 1, p. 79, fig. 74, *a-d,* occurs in the collection from Fort Cassin. The specimen is figured in order to aid in its identification. It presents the aspect of a dorsal valve, but is destitute of any mesial sinus. In all other respects it agrees very well with that species, having coarse distant striæ, with finer intermediate ones and very fine wrinkled or squamose concentric lines, parallel to the margin. The Canadian examples were from the Quebec group at Point Lévis.

Genus HEMIPRONITES, *Pander.*

Hemipronites apicalis.

PLATE 24, FIGS. 1–5.

Compare *Orthis? apicalis,* Billings; Pal. Foss., Vol. 1, p. 301, fig. 291.

Shell small, scarcely attaining a diameter of half an inch. Valves highly convex, the ventral having a rather high, somewhat pointed beak, scarcely or but slightly incurved. Outline transversely elliptical to semicircular in different individuals, with somewhat rounded cardinal angles, becoming more circular in outline with increased age. Hinge straight, nearly as long as the shell below in young specimens, becoming proportionally shorter

*All species, when not otherwise stated, are from the Birdseye limestone at Fort Cassin, Vt.

with age. Area moderately high, obliquely striated, and divided in the center by a narrow, highly rounded, covered deltidium, the perforation through which has not been observed. Dorsal valve less convex than the ventral, the area inconsiderable. Surface of the shell marked by fine radiating striæ, which are rounded and even on the shell, but when partially exfoliated or on the cast, appear to alternate in size. In the interior of the ventral valve the dental plates do not converge and unite with a central septum, as in the Russian species *adopectans* and *hemipronites*, of Pander, but are directed at right angles to the area to near the middle of the valve, then slightly diverge until they unite with the outer shell. At near the middle of their length they are united by a transverse plate, as seen in section which is united to a central septum, thereby dividing the interior of the valve into five distinct chambers instead of into three, as in the Russian forms above mentioned, which are the types of the genus *Hemipronites*. This latter feature of the interior ought probably to be considered of generic importance, but as so few Palæontologists have seen fit to recognize *Hemipronites*, which I think one of the well marked genera of Brachiopods, I hesitate to separate this species under a new generic name. I have supposed this might prove identical with the form described by Mr. Billings, as above cited, although by no means certain. Mr. B. states that in his shells the deltidium is "apparently open," while in this form it is positively closed. The Canadian specimens were from the Quebec group at Point Lévis.

Genus STREPTORHYNCHUS, *King*.

Streptorhynchus ? primordiale, n. sp.

PLATE 24, FIG. 7.

Shell small, and known only from a dorsal valve, which is flat and nearly semicircular in outline, being half as long as wide with the sides a little too full for a half circle, and the front margin of the valve a little straightened. Hinge line straight, a little longer than the shell below, with a narrow, almost linear area, divided in the centre by a proportionally large, covered deltidial callus, slightly imperfect in the specimen and showing the cardinal end of a slight mesial septum in the interior of the valve. Surface of the shell marked by narrow, flexuose, elevated, radiating striæ, with finer striæ between them. On the centre of the valve the larger striæ have only one, or sometimes no finer ones between; but toward the ends of the valve they become gradually more and more distant, so as to have two, three, or even four of the finer striæ between. The striæ are also partially interrupted as well as flexuose, giving a somewhat broken and irregular appearance to them. There are also very fine transverse striæ, microscopical in size, which cross the radiating striæ and produce under a strong lens a somewhat granulose surface. Ventral valve and interior unknown.

I can find no record of anything approaching this shell in character having been previously described. In its striation it is peculiar in the Lower Silurian—differing very materially from the striation of *Leptæna incrassata* and *Strophomena* (*Leptæna*) *plicifera*, Hall, from the Chazy limestone, and resembling more in its general features the Streptorhynchoids of the higher formations, of which it is undoubtedly a forerunner.

Genus LEPTÆNA, *Dalman.*

Leptæna, sp. ?

PLATE 24, FIG. 6.

A single specimen of a large Leptænoid shell, in recognizable form, and one or two other fragments have been found. The shell has been about one and a quarter inches long on the hinge, with slightly mucronate points, and having a convexity of a trifle less than a quarter of an inch, with an outline somewhat triangular in general form. The surface has been marked with strong, distant striæ, having several finer ones between, the number of which is not determinable in the exfoliated condition. The species seems to bear some relationship in form, curvative and surface striæ to *Strophomena aurora*, Billings, Pal. Foss., Vol. 1, p. 218, from the Quebec group, four miles northeast of Portland Creek, Newfoundland, but is more triangular in outline and has more pointed cardinal angles. The specimens are too poor for description.

Genus TRIPLESIA, *Hall.*

Triplesia lateralis, n. sp.

PLATE 24, FIGS. 9–11.

Shell of medium size, moderately convex and very much wider than long, with a narrow, linear cardinal area on the ventral valve, and a straight hinge about two-thirds as long as the entire width of the shell. Ventral valve with a deep angular sinus, extending from a short distance below the beak to the front of the valve, which is bent upward, forming a broadly triangular extension. Dorsal valve transversely elliptical in outline, but with a moderately straight hinge, beyond which the small beak projects so as to present the elliptical outline of the valve; mesial portions of the valve, scarcely elevated to form a mesial fold, but usually nearly symmetrically convex, the front broadly elevated to accommodate the extension of the ventral valve. Surface of the shell marked by fine concentric lines of growth and a few stronger varices. There is also an appearance of very fine, hair-like striations apparent on most of the specimens, which appears to be an internal feature of the fibrous structure, very apparent on the weathered or exfoliated specimens.

The species differs from any of those in the Trenton limestones in the proportionally greater width of the shell and in the less marked and less prominent mesial fold.

Formation and locality.—The species is quite numerous at Fort Cassin in the beds with the Cephalopoda herein described, but is as yet known only from single valves, and they usually in a bad state of preservation.

MOLLUSCA.

GASTEROPODA.

Genus TRYBLIDIUM, *Lindström.*

In Dr. Lindström's Silurian Gasterop. and Pteropoda of Gotland (Kongl. Svenska Veten. Akad. Handl. Band. 19, No. 6), p. 52, he redescribes, and on Plate 1 figures, species of his genus

Tryblidium, citing his *Fragmenta Silurica*, 1880, a work which I have not seen, for the original description. The description given in the first cited work is as follows:

"*Shell patelliform, obovate, anteriorly acuminate, posteriorly enlarged, forming a very low cone. Apex anterior, nearly marginal, with only very little area beneath. Margin of the ovate aperture arched, so that the animal, when fixed, was not entirely hidden beneath its shell. Muscular scars in six disconnected pairs, arranged in an oblong circle, open or nearly so towards the front part of the shell. Intimate structure of the shell somewhat resembling that of a Patella, being composed of thin strata of polygonous cells.*"

Among the fossils from Fort Cassin are several species of *Patelloid* or *Metoptoma-like* shells, which have nearly the characters of the above-described genus. But when strictly compared with the characters, as given in detail, vary considerable. Still I am unwilling to propose for them a new generic term, feeling that they should rightly be included with the Gotland species under the one name. All of the species differ from *Tryblidium* as characterized in having more than six pairs of detached muscular scars, and in having the basal margin straight, or so nearly so as not to be perceptibly curved in any of the examples seen; or, if curved at all, to be in the opposite direction to that represented and described in the generic diagnosis. Some of them also differ in being symmetrically oval instead of ovate, while one of them is almost symmetrically conical instead of having the apex nearly marginal on the anterior end, as required by the description; consequently, if they are included under the same genus, these must be considered as inconstant features, and therefore only specific instead of generic. Another, and perhaps more important difference consists in the muscular scars being "*open or nearly so towards the anterior end*" in the Gotland specimens; while in the Fort Cassin forms the scars are decidedly continuous around and below the apex of the shell, in a deep and continuous line, from the elongated clavate scars on the sides of the beak or apex, as they are in *Nacella;* at least in *N. pellucida* and *N. cymbularia*. Considering the above facts it would appear that the generic separation from *Nacella* would rest principally upon the disconnected muscular scars. The intimate shell structure, at least of one of the species, *T. ovatum*, is the same as in the Gotland specimens, composed of polygonal cells. Were it not for the separate and detached muscular scars there would be no valid reason for separating these shells from the living *Nacellas*, except their Palæozoic age.

Tryblidium ovale, n. sp.

PLATE 24, FIGS. 28 and 29.

Shell large for the genus, having a length of one inch and seven-tenths in the largest specimen, and nearly symmetrically oval in outline, being perhaps a trifle wider just forward of the line of greatest width than behind it, and a little more sharply rounded behind than in front. Greatest width equal to about three-fifths of the entire length on the base of the shell. Apex anterior, but little elevated above the margin and but slightly projecting beyond it. Surface of the shell highly convex transversely, very obtusely angular along the center from the beak posteriorly, a transverse section across the middle of its length being a very perfect paraboloid; the arcuation from the beak backward being a constantly decreasing or widening curve. Surface of the shell substance on the only fragment seen, which is near the beak, very finely striated concentrically. Shell substance rather thin. Muscular scars in detached pairs, of which seven are rather broad and somewhat rounded; the pair nearest the beak are elongate, narrow and curved, the anterior extremity being narrowest and curved downward, unites in a narrow raised line which passes beneath the beak in front. Apex of the beak, in the cast, marked by a small but distinct node, indicating an apical depression in the shell.

The distinctly oval and low convex form of this species, with the strongly arcuate medinal line, will be the distinguishing features.

Tryblidium ovatum, n. sp.

PLATE 24, FIGS. 23–25.

Shell smaller than *T. ovale*, the specimens yet observed not exceeding one and a quarter inches in length, very distinctly and markedly ovate in outline, being narrow and almost pointed in front and more broadly rounded behind, the point of greatest diameter being behind the middle of the length. Apex anterior, somewhat pointed, curved downward and slightly projecting forward of the anterior margin. Surface of the shell strongly convex, regularly rounded transversely, the point of greatest elevation being about half way between the apex and the middle of the shell. Surface of the shell marked by concentric lines of growth and by faint radiating striæ, the latter too fine to be perceived by the unaided eye. Muscular scars in eight detached pairs, very strongly marked on the casts, and constantly increasing in size from in front backward, each of them more or less round in form.

This species differs from *T. ovale* in the smaller size, ovate form, greater elevation, and in the form of the muscular scars.

Tryblidium conicum, n. sp.

PLATE 24, FIGS. 26 and 27, 32 and 33.

Shell rather small and broadly conical, with a nearly central or subcentral apex, the sides of the shell being in some specimens slightly convex, and in others almost straightly sloping ; basal outline broadly oval or subcircular. Height of the cone nearly equal to the shortest diameter. Surface of the shell unknown. Muscular scars in eight detached pairs, subcircular in outline and surrounding the cast at about the middle of the height or a little above the middle.

This shell is nearly of the form and dimensions of *Metoptoma Montrealensis*, Billings, from the Black River limestones at Pauquette Rapids on the Ottawa River, Canada, but there is no evidence on any of the specimens yet seen of radiating striæ as in that one. Otherwise it might readily be identical.

Tryblidium simplex.

PLATE 24, FIGS. 30 and 31.

Metoptoma simplex, Billings, Pal. Foss., Vol. 1, p. 346, fig. 334.

Shell quite small, pileiform, with an elevated, anteriorly curved, narrow and pointed beak, behind which the shell is strongly and highly arcuate. Aperture broad-ovate or oval, or in small individuals almost subcircular. Shell substance rather thick for the size; surface structure smooth as far as seen.

. This species is quite small and might readily be mistaken for the young of one of the other species having the anteriorly curved apex, but in the largest specimen seen, which is less than half an inch in its extreme length, the apex is more elevated above the apertural margin than in quite grown specimens of either of those species, while the back of the shell is very much more arcuate in proportion.

This species would appear to be parasitic to some extent, or at least sedentary, like the common Crepidulas, as it is found attached to fragments of other shells, in one case several being found upon a fragment of *Orthoceras Brainerdi.* The Canadian specimens were credited to the Calciferous formation near Merrickville, Canada.

Genus CLISOSPIRA, *Billings*, 1865.

Geol. of Canada, *Palæozoic Foss.*, Vol. 1, p. 186.

Comp. *Onychocheilus*, *Lindström*, *Kongl. Sv. Vet. Akad. Hand.*, Vol. 19, No. 6, p. 196.

In 1865 Mr. Billings proposed the genus *Clisospira* for a sinistral, trochiform gasteropod, from the Quebec group of rocks near St. Antoine, above Quebec, and described and figured the species on the same page under the name *C. curiosa.* From these figures alone one would naturally suppose the object to be the filling or matrix broken from the umbilical opening of a *Bellerophon* or *Bucania*, but on page 420 of the same work he gives a figure of what he supposes to be a specimen of the same species preserving the shell and showing more its true nature, but which is much more likely a distinct species from the one first figured. In 1876, while working over some fossils from the Trenton group in Wisconsin, I came across a specimen of a species which evidently belonged to this genus, and in Vol. 4 of the final report of Wisconsin described it as *Clisospira occidentalis.* See Geol. Wis., Vol. 4, p. 222, Pl. 5, fig. 21. From the study of this specimen I found it to be the cast of a complete shell, and not the filling of an umbilical cavity as I had supposed the Canadian examples might be.

In the above cited Swedish work, page 166, Dr. Lindström proposes the genus *Onychocheilus* for a group of shells, between which and the American shells I can see no reliable distinction; at least there cannot be between the Wisconsin species and his *O. reticulatum*. Among the Fort Cassin fossils I find another shell, which, although represented only by a single individual, seems without doubt to belong to this curious group, and which I shall describe under the generic name proposed by Mr. Billings.

Clisospira lirata, n. sp.

PLATE 24, FIGS. 16 and 17.

Shell small, sinistrally coiled, and consisting of not more than two very rapidly enlarging volutions, which are broadly convex on the upper surface and somewhat concave on the base. The aperture, which is imperfectly seen in the specimen, is somewhat semilunate and very oblique, the upper lip of the shell extending far over the lower one and rounded on the edge, while the lower one would appear to have been concave or receding on the edge. Surface of the shell marked by strong, oblique, lamellose ridges, parallel to the margin of the aperture, or crossing the volution obliquely backwards from the suture to the basal angle, and are separated by concave interspaces.

The lirated surface features will serve to distinguish this from any of the other described species.

Genus EUOMPHALUS, *Sowerby.*

Euomphalus circumliratus, n. sp.

PLATE 24, FIGS. 18–21.

Shell small, closely coiled, spire but little elevated, the inner volutions being inclosed for more than one-half of their vertical diameter within the outer ones. Section circular, except for the indentation of the preceding volutions. Umbilicus narrow and deep, less than the diameter of the smaller half of the adjoining volution. Surface marked by spiral ridges or raised lines with concave interspaces. Nine or ten of the ridges may be counted on the larger volution, those on the upper surface most distant, becoming gradually narrower on the side and below, as well as more distinct. Exterior surface unknown. Volutions three to four.

This species is known only from the internal cast; the shell, which is thick in substance, having adhered to the matrix. The nearest allied species is *Pleurotomaria? Calphurnia*, Billings, Pal. Foss., Vol. 1, p. 230; which differs very materially in the greater elevation of the spire, and stronger spiral ridges, as well as in the somewhat higher volution as seen in section.

Genus RAPHISTOMA, *Hall.*

Raphistoma compressum, n. sp.

PLATE 24, FIGS. 14 and 15.

Shell of medium size, very depressed convex above and sub-discoidal, volutions three and a half to four, transversely narrow-ovate, acute on the outer edge and rounded on the inner, the inner ones impressed below the outer at the suture lines, the upper surface being swollen just outside of the suture, and very moderately concave a little within the outer margin; giving the form known as an o-g. to a cross section of the upper surface. Outer edge sharply acute. Base of the shell broadly umbilicate and almost regularly convex, the greatest convexity being a little within the median line. Umbilicus one-third the entire width of the shell. Aperture transverse, almost symmetrically acute-ovate, rounded on the inner margin, the upper lip strongly receding from the suture to the outer edge of the volution, where it appears to have been somewhat deeply notched. Lower lip not definitely determined, but apparently nearly conforming to the upper, except in being less advanced near the suture. Surface of the shell marked only by transverse lines of growth on the upper side, which sometimes produce slight undulations on the surface parallel to the margin of the aperture.

This shell is of the type of *R. lenticularis*, Sow., and corresponds in general form with *Pleurotomaria Canadensis*, Billings, Pal. Foss., Vol. 1, p. 342, fig. 328, except that it is more compressed and has fewer and more rapidly increasing volutions. The *P. Harpya*, Billings, loc. cite., p. 227, not figured; would appear to be most nearly allied to our shell in its depressed form;

but in that one the volutions must increase very much more rapidly, as there are only three allowed for in a specimen having a width of two and one-third inches, while this one possesses between three and four in a shell of only one inch and an eight in its greatest diameter. No other shell has been described having greater affinities with this one, than the two above mentioned.

Genus HOLOPEA, *Hall.*

Holopea Cassina, n. sp.

PLATE 25, FIGS. 6 and 7.

Shell of more than an average size for the genus, attaining a height of about one and a half inches, by a transverse diameter of rather more than one and three-fourths inches, and consisting of three, or more than three, very ventricose and subangular volutions. Form broad-ovate, erect, or but little oblique, the volutions very rapidly increasing in size with additional growth of the shell. Body volutions very gibbous, subangular above the middle, and also showing a tendency to angulation again below the middle, forming a broad, somewhat obliquely flattened space on the middle of the volution. Sutures very deep and distinctly marked, the upper volutions of the spire being strongly exsert, the apical angle being not much less than eighty degrees. Axis perforate and the margin of the umbilicus abrupt, the perforation being small and narrow. Aperture large, ovate, acute above and sharply rounded at the base, judging from the form of the volution. Substance of the shell moderately thick, and the surface marked only by fine transverse lines of growth.

This shell has its nearest ally in *H. ovalis*, Billings, Can. Nat. and Geol., Vol. 4, p. 351, fig. 2, from which it differs in the more ventricose and subangular volutions, and in the deeply marked sutures.

Holopea arenaria.

PLATE 25, FIG. 5.

? *Murchisonia arenaria*, Billings, Can. Nat. & Geologist, Vol. 4, p. 359, fig. 9.

A specimen of *Holopea*, which appears to be identical with that figured by Mr. Billings, loc. cite., occurs in the Fort Cassin collection; at least it corresponds so closely with the figure and description there given, that I do not feel safe in considering it as distinct. The specimen is however a true *Holopea*, and although being distinctly angulated along the middle of the body whorl, has certainly never possessed the characteristic slit of *Murchisonia*, as the lines of growth are shown on the shell surface to form only a very broad V shaped notch, which occupies the entire width of the volution, instead of only a narrow central band. If the Canadian shell shall prove to be a true *Murchisonia*, the above used specific name might be retained for the present species under *Holopea*, although by no means a descriptive one. The Canadian shell perports to have come from the Calciferous sandstone, at Godmanchester, Canada; which fact might in itself, were it properly located, throw some doubt on their identity. As I have not seen that shell, I am unable to satisfactory decide the question.

The Trenton limestone, from its base upward, is characterized by a group of gasteropods which have heretofore been classed under the genus *Murchisonia*, but which differ in several essential points from that genus, if not from the entire family to which it belongs. This group may be said to be typified in the shell known under the name *Murchisonia bicincta*, Hall (= *M. Milleri*, Hall, S. A. Miller's Cat. Pal. Foss., p. 244), and its varieties. They have a general resemblance to *Murchisonia*, but are usually more tightly coiled; that is, they are wound more closely around their axis, and embrace the upper volutions lower down, leaving more of their height exposed above the sutures, so that the upper volutions may be said to be more exsert than in any of the true *Murchisonias*, usually to considerably below the middle, or to below the point of greatest diameter. They are also always characterized by one or more carina, or spiral ridges; one of which always marks the periphery of the volutions. This central ridge or carina marks also the bottom of a receding notch or sinus in the outer lip of the shell, of a greater or less depth, but not necessarily a slit like that of *Murchisonia* and *Pleurotomaria*. In very many of the specimens, especially of *M. Milleri*, Hall, this central ridge is occupied by a thin, flat, flange-like expansion, which is serrated on the edge like a circular-saw, and is not unfrequently more than an eighth of an inch in width, while being nearly as thin as paper. This feature is seldom seen on the limestone specimens, as it is always left in the rock in separating it from the the shell. But in the buff-colored dolomitic limestones of Southern Wisconsin, I have often seen it beautifully shown in the matrices where the shell substance had been removed, and its imprint left. Another feature in which they differ from *Murchisonia*, is in the tendency which they exhibit to uncoil, or for the whorls to become disconnected in the advanced stages of growth. This feature prevails to so great an extent among the specimens found at Beloit, Wisconsin, that few shells of more than an inch and a half in length fail to show it more or less. It is also well shown in the figures given by Mr. Salter in Decade 1, Can. Org. Remains, Pl. 4. They also differ in the form of the aperture, in that the columella is never solid, and that they are usually if not always minutely umbilicated, while *Murchisonia* proper has a solid axis. For this group of shells I propose the generic name *Lophospira*, in allusion to its keeled structure.

LOPHOSPIRA, New Genus.

Shells univalve, with elevated spires and strongly carinated or keeled volutions, whorls closely coiled in the upper part, but often becoming disconnected below from a too rapid descent of the coil. Central keel marking the position of a sinus or notch in the outer lip of the aperture. Axis usually minutely perforate when the whorls are not disconnected. Types *Murchisonia bicincta* = *M. Milleri*, Hall, and *M. helicteres*, Salter.

Lophospira Cassina, n. sp.

PLATE 25, FIGS. 1–4.

Shell unusually robust for the genus, being nearly as wide as high, with the body volution forming the great bulk of the shell. Volutions three to three and a half in large specimens, coiled considerably below the point of greatest diameter of the whorl above in the upper part of the spire, and still further below in larger ones, so as to leave a greater proportion of the upper one exposed. Volutions rounded on the periphery above, and becoming more angular with advanced age, the surface above the carination becoming flattened obliquely, and that below the carination more gently convex, the lower portion being extended and broadly rounded at the base below the columella. Aperture large, angular at the widest part, and the margin of the lip receding at this point; above, it is angular, and below rounded; columella coated by a flattened angular callus. Axis very slightly perforated. Surface of the shell comparatively smooth; no carina exists other than that forming the periphery of the volution.

The species is of the type of *Murchisonia ventricosa*, Hall, Pal. N. Y., Vol. 1, p. 41, Pl. 10, fig. 3, but is altogether more robust and less elongated proportionally. Its bears also similarity, in its proportions, to *Murchisonia* (?) *varicosa*, loc. cite, fig. 7, in wanting the several carinæ of that species, and the varicose surface ascribed to it.

Both of the above-mentioned species are from the Birdseye limestone, and both will fall under the genus *Lophospira*. The present species being peculiar, as compared with them, and also with all other species hitherto described, in the downward extension of the columella, prolonging the aperture and forming a short beak-like process, while most species of the genus have the base of the aperture either obtusely or acutely rounded. In Vol. 4, of the Geol. of Wisconsin, Pl. 5, fig. 18, I have figured a specimen which I referred to *M. ventricosa*, Hall, but which is much shorter than the typical form of that species, and is probably distinct, but it differs from this one in the flattening of the upper side of the volution and in the less prolonged base, as well as in possessing an additional carina on the upper side of the whorls. This present shell may be said to bear some resemblance to a *Scalites;* but in *Scalites angulatus*, Con., perhaps the only true species of the genus yet known, there is, so far as I can obtain the information from the best specimens I have access to, a rather large open umbilicus, and a distinct notch at the inner base of the aperture, with a ridge above it, which I am inclined to think when properly understood will show close relations to the *Actæonidæ*.

Since the above has been in type I have obtained other and more adult specimens, which show a distinct callus coating on the columella, and an extension below of the aperture forming a broad rounded base, the lower part of the columella being bent. There is also a greater variation in the form of the spire than I had supposed, some being much lower and the volution more angular than in those before used. There is also on one, figured on Plate 25, fig. 4, a ridge seen on the flattened part of the columella, the full value of which is not yet understood.

Genus ECCULIOMPHALUS, *Portlock.*

Eccullomphalus volutatus, n. sp.

PLATE 25, FIGS. 8–11.

Shell somewhat larger than a medium size for the genus, measuring fully two inches in its greatest horizontal diameter on the largest individual before me ; and consisting of from one and a half to fully one and three-quarter volutions, which are distantly and loosely coiled, being entirely disconnected and distinct from each other, and quite rapidly increasing in dimensions. The shell is flattened or flatly rounded on the lower side, if considered as a dextral shell, and rather sharply ridged on the upper side, and is coiled in the plane of the flattened surface, which leaves the spire depressed so as to resemble a loosely coiled *Maclurea*. Substance of the shell only moderately thick, and marked by transverse wrinkles of growth, or smooth. The internal cast where the shell is removed shows longitudinal ridges, faintly indicated.

This shell is a true *Ecculiomphalus*, according exactly with Col. Portlock's original description. In general appearance it somewhat resembles *E. intortus*, Billings, Can. Nat. and Geol., Vol. 6, p. 321, fig. 5, but does not increase in size so rapidly and has an entirely different cross section, being acutely pyriform instead of nearly circular as in that one.

CALAUROPS, New Genus.

Καλαῦροψ, a Shepherd's Crook or Staff.

Shell univalve, discoidal, convolute, inner volutions closely coiled, outer one disunited and projected in a straight line. Type *C. lituiformis*.

This name is proposed for a fossil shell having some resemblance to *Ecculiomphalus*, Portlock, but differing in having the inner volutions closely coiled, although not, in the type species, embracing. The inner volutions alone would present the appearance of a species of *Euomphalus*, from which it differs in having the outer volution disconnected and at length projected in a straight line. The *Ecculiomphalus Canadensis*, Billings, from the Calciferous sandrock in Canada (Can. Nat. & Geol., Vol. 6, 1861, p. 320), will also fall under this genus. One peculiar feature noticed in all the specimens of the typical species, consists in the filling up of the earlier parts of the shell as the animal increases with age, and an apparent withdrawal of the animal from these parts. This is shown by the interior parts of the shell, as far as the animal occupied it at the time of death, being filled with foreign matter; while behind, the space is entirely filled with crystalline material, which has resulted from the thickening of the shell. This is sometimes carried on so far as to leave only the straight deflected part of the shell to be occupied by the animal.

Calaurops lituiformis, n. sp.

PLATE 26, FIGS. 1–4.

Shell of moderate size, sub-discoid and convolute, consisting of about two and a half volutions, of which the inner ones are united but not impressed one into the other, and the outer or principal volution becomes disunited and free, and the outer part projected in a straight line to the extent of more than four and a half inches from the back of the volution. Spire very depressed convex, or perhaps sometimes even flat; the upper surface of the volutions being very moderately convex; below, the shell is more convex, being nearly semicircular, and the edges obtusely angular or rounded, the outer edge usually the most salient. Substance of the shell very thick and heavy, the surface as shown on some weathered portions, marked transversely by strong rugose ridges, though often apparently also smooth or nearly so.

I had at first supposed this to be identical with *Eccuomphalus Canadensis*, Billings, figured on page 320, Vol. 6, Can. Nat. & Geol., 1861; but on comparing it with the type specimen of that species which Mr. J. F. Whiteaves, Palæontologist of the Canadian Survey, kindly loaned me for comparison, I find it to differ in some essential points. The lower side of the Canadian species is very much more convex, in fact is much more than half of a circle and quite gibbous, and the decrease in size backward much more rapid than in this species, while the coil has been smaller and more abrupt.

Formation and locality.—This species is from the lowest rock exposure seen at Fort Cassin, which is a coarse, somewhat crystalline black limestone closely resembling the Maclurea beds, at Chazy, N. Y., and on Isle La Mott. It appears to have been very abundant in the rock, from the number of parts of individuals seen in the hand specimens, but no other fossil has been recognized in the same bed except the caudal plate of a trilobite of small size, resembling *Bathyurus extans*, Hall.

Genus PLEUROTOMARIA, *Defrance.*

Pleurotomaria ? . Etna ?

PLATE 24, FIGS. 12 and 13.

? Pleurotomaria Etna, Billings, Pal. Foss., Vol. 1, p. 226, fig. 210.

Among the collections from Fort Cassin are parts of many specimens of a shell closely resembling the above-named species, but none of them in a sufficiently perfect condition to afford positive means of identification. Still they are so nearly like it as to make it quite unsafe to describe them under another name. The surface, as shown between the separated volutions, when broken, is beautifully marked with spiral striæ, but whether or not this may correspond to the "surface striated" as stated by Mr. Billings in his description of that shell, I am not sure. Mr. Billings's specimens were from the Quebec group in Newfoundland.

Genus MURCHISONIA, *D'Arch. & Vern.*

Murchisonia ? prava, n. sp.

PLATE 24, FIG. 22.

Shell somewhat below a medium size, the type specimen measuring in the extreme but one and one-fourth inches, and consisting of about six volutions, allowing for the apex, which is absent in the specimen used. Volutions convex, somewhat regularly so, the upper four and a half regularly coiled and regularly increasing in size; below which point, that is, for the lower one and a half volutions, they are irregularly coiled in the specimen, being more closely wound, so as to constrict the diameter and bend the spire over to the side of the outer lip of the aperture. In this condition it resembles the bent forms of *Subulites.* Aperture large, expanded laterally and below, with a short, nearly straight columella on the inside, which is not thickened, axis imperforate. Surface of the shell smooth, but marked by an elevated band along the middle of the volutions, indicating a slit in the outer lip of the aperture, which is imperfect in the example in hand.

The shell presents precisely the aspect of one of the bent forms of *Subulites*, except in the form of the aperture, and in the possession of the band on the middle of the volution. In separating the specimen from the limestone matrix, most of the substance of the shell remained in the rock, so that only a small portion of the surface can be seen, and the central part of the outer lip had been broken off, before the rock in which we found it, came into our possession, but on the lower two volutions of the cast the band is very distinctly marked, forming a raised double band, and, through the substance of the shell remaining in the matrix, the band can be readily distinguished, leaving no doubt as to the reality of this feature. The expanded form of the aperture is somewhat different from that common to the genus, as is also the bending of the spire from irregular coiling. This latter may possibly be an accidental feature, but it appears so extremely natural in its characters, and resembles so closely the bending in several forms of *Subulites*, and in many of the Pupa group of land shells, that I strongly incline to the belief that it is a natural feature of the species.

Murchisonia (Fusispira?) obelisca.

PLATE 26, FIGS. 5 and 6.

Shell above a medium size for the genus, having been from three to four inches in length, and having an apical angle of about twenty degrees. Volutions ten or more in number in the adult specimen, very moderately convex to depressed convex, or even flattened on the surface in the direction of the spire, but with the sutures rather deeply marked; the lower volutions rather more prominently rounded than those above, and when the shell is retained appear obscurely angular a little below the middle of the exposed portion. Aperture elongate, semi-ovate, pointed, and extended somewhat below, with the columbella rather straight. Surface of the shell smooth, or with obscure lines of growth, their direction not traceable.

This species bears considerable resemblance to *M. Anna*, Billings, Can. Nat. and Geol., Vol. 4, p. 358, fig. 8 *a.*; but the volutions are more elongated than in that one, giving it a less compact appearance which is quite distinctive. It also has some resemblance to *M. Artemesia*, Bill., Pal. Foss., Vol. 1, p. 345, differing from it in the direct opposite from which it differs from the first. I am not positive this may not be a *Fusispira*, though the volutions appear to be slightly angular in the middle as in *Murchisonia*. The aperture bears some resemblance to the former genus.

Genus SUBULITES, *Conrad.*

Subulites obesus, n. sp.

PLATE 26, FIG. 7.

Shell rather large, short but very ventricose, composed of but few, but very rapidly enlarging volutions, probably not more than four to four and a half in number; very depressed convex on the surface, but with well marked sutures, giving the shell a very obese appearance. Aperture and anterior portions unknown. Surface of the shell comparatively smooth, or marked only by very fine lines of growth. Substance thin.

This species is of the general form of *S. Psyche*, Billings, Pal. Foss., Vol. 1, p. 187, fig. 169, but is considerably more rapidly enlarging and more obese, as well as of larger size. The anterior parts are lost in the only specimen collected, so their features cannot be determined. It has the general appearance of a *Subulites*, still it is not improbable it may be only another form of *Holopea*.

Genus BELLEROPHON, *Montf.*

Bellerophon Cassinensis, n. sp.

PLATE 26, FIGS. 8 and 9.

Shell of medium size, laterally compressed, rounded on the back, and nautiloid in form; with a solid axis. Aperture crescentiforme, or semi-oval, with the inner side strongly modified by the intrusion of the inner whorl. Margin of the aperture or lip extended forward on the sides, and deeply sinuate on the back. Shell smooth as far as can be determined by the specimens in hand.

This species cannot be mistaken for or confounded with *B. bilobatus* of the formations above, as it is so much more compressed on the sides, which gives it almost exactly the form of *Nautilus pompilius* in miniature.

CEPHALOPODA.

Genus ORTHOCERAS, *Breynius.*

Orthoceras Brainerdi, n. sp.

PLATE 27, FIGS. 14–16.

Shell moderately large, at least attaining a diameter of two and a half inches below the chamber of habitation, and the rate of increase so very gradual that this would give it a length of between three and four feet between this point and the apex. Another specimen, two and one-eighth inches in diameter at the upper end, decreases backward three-eighths of an inch in a length of seven inches, which would account for a length of about forty-five inches. Section of the shell broad oval, a section measured gives the diameters of one and seven-tenths inches, by two and two-tenths inches, or a little more than three-fourths as wide as long. Septa thin and fragile, very closely arranged, and scarely increasing their distance with the increased growth of the tube. Specimens one and one-fourth inches in diameter have them fully as distant as the largest ones seen; their usual distance giving from seven to eight chambers to the inch; varying somewhat in different individuals. One specimen having a diameter of nearly two inches has only about six chambers to the inch, but they appear exceptionally distant in this one, among those present. The septa are peculiar in being undulated in their direction across and around the tube. The siphon, which is a straight tube, slightly constricted within the chambers, oval in outline, having nearly the same proportions as the outer tube but a little broader and of a diameter equal to about two-sevenths, or a little less than one-third of the transverse diameter of the outer tube at the same point where measured, is situated close to the side of the shell, and appears to be uniformly placed on the right hand side of the central line, when held toward you, with the larger end of the tube upward, so as to be always eccentric to the axis of the shell, causing an irregularity at this point in the margin of the septa, lifting them, as it were, upward at the point of its junction with the outer tube. There is then a gentle dip downward on each side of the siphonal line, and a broad curvature upward on each side of the outer tube, with two shallow, but rather sharp depressions on the opposite side of the tube, the most marked of which is diagonally opposite the position of the siphon. The septa, although somewhat deeply concave in the direction of the longer axis of the shell's diameter, is not very convex in the opposite direction, but is rather monoclinal from the inner side of the siphon to the opposite side of the tube, though in some specimens showing a slight convexity. The outer surface of the external tube, although preserved in patches on several individuals, does not show any particular markings, as they are more or less acted upon by the weather.

The very gradual increase in diameter of the outer tube, together with its large size, and the closely arranged septa and narrow chamber, will suffice to distinguish this from any other described species. In its narrow chambers it is related to *O. multicameratum*, Hall, from the Birdseye and Black River limestones, but in its more gradual rate of increase and the undulations of the septa, large size and lateral siphon, it is entirely distinct. It is also somewhat closely related to *Endoceras* (*Cameroceras*) *subannulatum*, Whitf., from the Beloit, Wisconsin, lower Trenton limestones (see Geol. Wis., Vol. 4, p. 230, Pl. 7, fig. 15), but the septa are more thoroughly undulated, the siphon much smaller in proportion, and the surface has not been annulated as in that one. The species would most likely pertain to the section to which Mr. Conrad gave the name *Cameroceras*, should it be accepted as a generic distinction.

Orthoceras cornu-oryx, n. sp.

PLATE 27, FIGS. 1, 2 and 6.

Shell of small size, not exceeding three and a half or four inches in length, as far as shown by the specimens in hand. Section circular, and the tube very rapidly expanding with increased growth. Tube strongly annulated, especially so near the upper part, but more obscurely so below, and somewhat gradually increasing in size; the annulations near the upper part of a specimen, which is less than three inches long, measuring one-fourth of an inch from crest to crest. Rate of increase in the size of the tube one in four, being a quarter of an inch to an inch of length. Septa moderately concave, very closely arranged, there being nine chambers in half an inch in the larger part of the septate portion of the specimen mentioned above, and the outer chamber, or non-septate part, extending more than half the length of the shell. Siphon very small, situated nearer to the outer shell than to the centre of the tube, very slightly enlarging in diameter at its junction with the septa. Shell substance thin, and so far as can be seen from adhering portions, appears to have been smooth on the surface.

The species is nearly allied to *O. priamus* and *O. Lamarcki*, Billings (Pal. Foss., Vol. 1, p. 253, fig. 239, and p. 347), but differs from the former, which it most nearly resembles, in being a little more rapidly tapering; in having more distant and differently constructed annulations, broader and not so deep; in the smaller sized and differently situated siphon, and in wanting the concentric surface striæ of that species. The shell appears to have been an abundant form, as fragments of two or three individuals are not uncommonly found in single hand specimens. The largest example in the collection is less than an inch in diameter at the top of the outer chamber.

Genus GOMPHOCERAS, *Sowerby*.

Gomphoceras minimum, n. sp.

PLATE 27, FIGS. 3–5.

Shell very small, scarcely reaching one inch in length even if continued to a point, and the largest diameter not exceeding three-eighths of an inch. Tube rather rapidly enlarging to the middle of the proportionally short outer chamber, above which it again slightly contracts. Section of the tube circular. Outer chamber measuring not more than about one-third of the entire length of the shell. Septa very moderately concave and closely arranged, nine or ten chambers occurring in the length of one-fourth of an inch in the middle of the chambered portion. Siphon comparatively small, and situated near the margin. Surface of the shell, on a small fragment seen, extremely finely striated concentrically, and its substance proportionally thick.

This is an extremely diminutive species, but the form of the outer chamber and aperture shows it to be adult, or nearly so; as the terminal contraction is present, and although the aperture may not have been completed at the time of the death of the animal, it was so nearly so that the size of the shell would not have been materially increased. The small size of the species will insure its identification.

Gomphoceras Cassinense, n. sp.

PLATE 29, FIGS. 1–3.

Shell of about a medium size, the most entire specimen obtained indicating a length, if projected to a point at the lower extremity, which is imperfect, of about four inches, with a transverse diameter at the largest part of very nearly two inches. Section circular when not compressed, the tube very rapidly enlarging upward to the middle of the outer chamber, above which point it is again contracted to the upper margin. Outer chamber wider than high, those immediately below measuring about a sixth of an inch in depth, but very perceptibly decreasing downward, quite deeply concave and nearly direct across the tube. Siphon large, situated only about one-half its own diameter within the margin of the tube; its sides very slightly concave within the chambers. Outer shell surface apparently smooth, no perceptible surface structure being visible on portions preserved, even where no weathering has taken place. Lower chambers showing on the cast slight longitudinal furrows over some parts of their surface, resulting from the muscular pits visible also along the base of the outer chamber.

I do not find that any species of *Gomphoceras* have been described from the lower portions of the Trenton group of rocks in this country heretofore. *Oncoceras* have been somewhat common in lower Trenton in the West, and are not so extremely uncommon in the Trenton proper in New York; but no true *Gomphoceras*, so far as I can ascertain, have been recognized. The species here described may therefore be considered as the earliest forms of the genus until others are found below them. I think there can be no question as to the generic relations of this species, as there is not the slightest indication of curvature. A very slight expansion of the upper margin is indicated, like that often seen in *Oncoceras*, above the usually constricted aperture, but it is no more than might result from a thinning of the shell substance near the lip of the specimen.

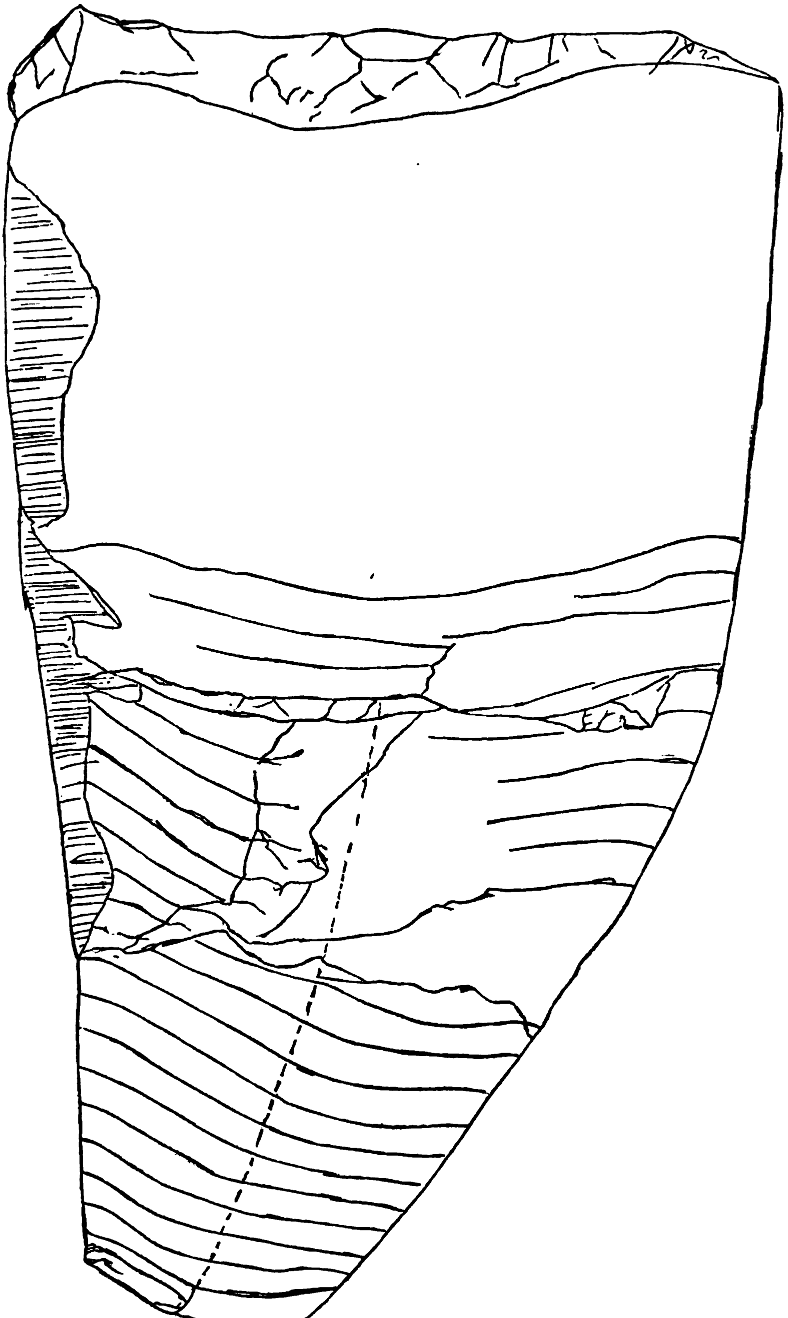
Genus PILOCERAS, *Salter*.

Piloceras explanator, n. sp.

PLATE 28, FIGS. 1–4.

Shell large, at least ten inches in length by four and a half or five inches in width, strongly compressed laterally, and very elongate-ovate dorso-ventrally in section; the acute end of the section being the siphonal side or edge of the shell. Shell curved in a longitudinal direction, the siphonal side being nearly straight, while the opposite side is curved, according to the increased width of the tube, to a point a little below the base of the outer chamber, above which it is again somewhat contracted; thereby producing the curved feature noticed in nearly all the siphons which have been described under the name *Piloceras*. Externally the shell resembles a large, slightly curved *Phragmoceras*, broken off just below the apertural contraction. Septa rather numerous, being arranged at a distance of about one-fifth of an inch apart in the middle of the specimen's length; there being about that number of chambers to the inch, which are slightly decreasing in their distance from each other downward, as far as the specimens are preserved. The septa are strongly curved on the sides of the shell, being lowest on the middle of the side and advancing toward the edges, somewhat higher on the back than on the siphonal side; laterally they are only moderately concave. Siphon very large, attached to the inner surface of the outer tube on the straight side, obtusely pointed at its lower end, and very rapidly enlarging upward, so that at a distance of five inches from the point of the outer tube its diameter has become rather more than two inches, in one instance; and in another in a length of four and a half inches it has reached a diameter of two and a quarter inches in its greatest width. Its form is at first only slightly transverse in the direction of the flattening of the outer body, but as it advances upward it becomes more flattened. This may be to some extent the result of compression, but not largely so. The substance of the siphon is very thick, but it is not septate internally as described by Mr. Salter, but composed entirely of solid matter, crystalline in the specimens, with an internal cavity resembling that figured by Mr. Billings in his Pal. Foss., Vol. 1, p. 256, fig. 240, *a*, but not so extreme; the inside cavity extending lower, and shallowing more gradually. The siphons, as found separate in the rock, are obtusely conical, slightly curved, nearly solid bodies; somewhat rounded in the lower part, but flattened above; the internal cavity extending more than half the length, and somewhat gradually tapering upward. The outer surface is strongly marked with encircling ridges, much advanced and acutely bent on the straight side or edge, rapidly descending on the sides and crossing the opposite edge in a broad curve, to meet the corresponding ridge from the opposite sides. These ridges mark the points of attachment of the septa of the outer chamber. The septa, where they unite with the siphon, are bent downward, becoming slightly funnel-formed near the junction. Surface of the outer shell comparatively smooth. A few transverse wrinkles of growth are visible on some fragments of the outer chamber preserved. Its substance is very thin, and through it, along the base of the outer chamber, can be traced the small rounded pits of muscular attachment seen in nearly all fossil cephalopods of this order, leaving indications of longitudinal lines or flutings on the cast of from fourteen to sixteen to the inch.

These specimens, so far as I am aware, are the first and only ones known, which show the outer chamber and parts of the organisms in connection with the peculiar solid siphons usually described as species of *Piloceras*. Whether they are congeneric with the specimens originally described by Mr. Salter, and on which he founded the genus *Piloceras* may be considered as yet questionable. If Mr. Salter's specimen was as distinctly septate



PILOCERAS EXPLANATOR, Wh., $\frac{4}{5}$ Nat. Size.

as his figure would suggest, and he certainly was a good observer, I should incline to consider them as distinct; as in that case the animal must have had a siphonal sac, subject to periodic lifts, just as in the case of the main portion of the body in forming the septa, while in the case of our specimens the deposit of the solid part of the siphon was constant and gradual; differing in this respect from the formation of new septa in the outer tube. Moreover, the siphonal sac must have been obtusely rounded and entirely closed at the lower end; in this respect entirely differing from that of the generality of Cephalopods, at least from those of the Palæozoic rocks, where they were open at the lower end, or at least where no shelly deposit took place except from the sides of the sac, if they were closed.*

Genus CYRTOCERAS, *Goldfuss.*

Cyrtoceras Boycii, n. sp.

PLATE 29, FIG. 4.

Shell of medium size, strongly curved and rather rapidly expanding from the point upward, the diameter increasing from one-fourth of an inch to an inch and a half in a length of about four inches, measured along the outside curve. Septa numerous and moderately concave, strongly arching upward on the outer side; eight chambers can be counted in one inch of length where the diameter is one inch at the middle of the space where they are counted. Siphuncle very large in proportion to the diameter of the shell, occupying nearly or quite one-third of the diameter and centrally situated; strongly lobed and rounded within the chambers, like that of an *Ormoceras* or *Actinoceras.* Outer chamber and surface of the shell unknown.

This species in its dimensions, curvature and closely arranged septa, very closely resembles *C. macrostomus*, Hall, from the Trenton limestones of Mineral Point, Wisconsin ; but differs very materially in the form, size, and situation of the siphon, which will readily distinguish it whenever observed.

Formation and locality.—In the dove-colored limestone of the Birdseye, at Isle La Motte, Lake Champlain.

*See observations on the vaginate Cephalopods in Bulletin No. 1, Am. Mus. Nat. Hist., pp. 25–27.

Cyrtoceras acinacellum, n. sp.

PLATE 27, FIGS. 10–13.

Shell small and slender, dorso-ventrally oval in section and not exceeding three-sixteenths of an inch in its greatest diameter; very slightly curved throughout, and but very moderately increasing in diameter with the increased length of the tube. Septa proportionally distant, only about four chambers occurring in a length equal to the dorso-ventral diameter at the outer one counted, very deeply concave, and very strongly arching upward on the outer edge, and but little less so on the inner side, while on the sides of the shell they are deeply bent backward. Siphon small, dorsally situated. Substance of the shell thick and the surface very minutely striated transversely.

This species is remarkable for its very small size and comparatively distant septa, which, like the outer shell, has been strong. No contraction of the aperture can be seen on the examples yet found.

Cyrtoceras confertissimum, n. sp.

PLATE 27, FIGS. 7–9.

Shell small, transversely oval in section, and very gently expanding with increased growth; a fragment of a specimen having a length of one inch and seven-tenths, measured on a straight line, increases only about one-tenth of an inch laterally and about three-twentieths of an inch dorso-ventrally. The curvature of the shell is moderately rapid, and slightly more so above than in the lower part. Septa moderately concave, very numerous and very closely arranged, there being ten and eleven chambers within the space of half an inch as measured at the opposite ends of the specimen. Siphon proportionally small, situated less than its own diameter within the outer margin of the shell, and very slightly constricted within the chambers. Surface unknown.

The species is remarkable for its transverse form and closely arranged septa. The specimen figured is the most entire one yet observed; several fragments of it have been noticed, but so imperfect as to show only a few chambers, and those mostly broken. It appears, therefore, to have been a very fragile shell and to have been easily destroyed after the death of the animal.

Genus NAUTILUS, *Breynius.*

Nautilus Kelloggi, n. sp.

PLATE 30, FIG. 1, and PLATE 31, FIGS. 4 and 5.

Shell, so far as known, only of very moderate proportions, the largest specimen yet observed being only two and three-eighths inches in its greatest diameter, and consisting of about three and a half volutions, which are essentially circular in a transverse section, being scarcely indented on the inner surface by the preceding ones. The tube, however, increases very rapidly in diameter in comparison to the additional length, and the dorso-ventral diameter is possibly a little greater than the lateral. At the outer end of the largest specimen, which is still septate, the dorso-ventral diameter is one inch and one-eighth, while the lateral diameter is perhaps a sixteenth of an inch less. Septa moderately distant, and gradually increasing in their distance as the shell advances in size, not very deeply concave, but somewhat more so dorso-ventrally than from side to side; which feature gives them a slightly concave or backward curvature on the sides of the tube, notwithstanding its circular section. Siphon rather large and the substance thick, at least twice as thick as that of the septa at the same part of the tube, straight, being neither enlarged or contracted in the chambers, and situated about its own diameter within the dorsal margin. Substance of the outer shell moderately thick, the surface marked by fine, even, thread-like concentric striæ, which cross the sides of the tube with a strong backward curvature from the suture, and forms a rather broad, though not deep sinus on the rounded dorsum.

This shell has rather strong affinities with *Lituites* (*Nautilus*) *undatus*, Conrad, but increases more rapidly in size according to the number of volutions, consequently in a shell of the same diameter it would have fewer volutions. Besides the section of the tube is so nearly circular that it cannot be said to have any other form, whereas that one is quite perceptibly quadrangular in the two figured specimens, Pal. N. Y., Vol. 1, Pl. 13, fig. 1, and Pl. 13 bis, fig 1. So far as can be determined from the specimens in hand the surface of this species has not been undulated to the extent shown on the specimens of that species above mentioned,

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but this feature cannot be relied on with certainty. I have placed it under *Nautilus* rather than under *Lituites*, as we have no evidence as yet for supposing either this or *L. undatus* ever becomes free at the outer part, as in *Lituites;* and the position of the siphon is not far enough removed from that of *Nautilus* to warrant a generic separation from that genus.

Nautilus? Champlainensis, n. sp.

PLATE 31, FIGS. 1–3.

Shell below a medium size, discoidal and very broadly umbilicate, the outer volutions embracing the inner ones to only a very small part of their diameter, at most not more than one-third. Volutions about three and a half, slender, nearly circular in section, except for the emargination on the inner side and a very slight flattening, scarcely perceptible, on the back; the outer volution with a moderately expanded aperture when the shell is completely grown. Septa closely arranged and moderately concave nearly direct across the volution when not distorted, being very slightly advanced on the ventral margin and very little depressed in crossing the dorsum. Siphon of moderate size, subcentrally situated, being nearest to the dorsal side and very slightly constricted in diameter within the chambers. Surface of the shell marked by moderately strong striæ of growth, which are directed backward from the suture line to the sides of the dorsum, which they cross, forming a broad, deep sinus. On the outer chamber, or perhaps more properly on the outer half of the outer volution, the striæ are grouped to form strong, undulating folds on the surface, parallel to the margin of the expanded aperture, but far less in size than the final expansion.

This species bears considerable resemblance to *Lituites? Seelyi*, herein described, but differs in having a smaller number of volutions in the finished shell, and in their being very slightly more rapidly expanding, and less compressed laterally. But the principal distinction, and the only one which can be relied upon for the separation, is the expanded aperture. In the absence of this feature it is barely possible to distinguish the species, and until this feature was obtained more or less distinctly in two or three individuals, I was unable to find characters by which I could separate them, having included both under that form. The final form, however, so far as yet seen, is never so large in the completed shell as in *L. Seelyi*, although the volutions are very slightly more rapidly expanding in diameter.

Genus LITUITES, *Montfort.*

Lituites Seelyi, n. sp.

PLATE 32, FIG. 1, and PLATE 31, FIG. 2.

Shell rather above a medium size, with somewhat closely coiled volutions, which increase but very gradually in diameter with the increased age of the shell; the inner ones imbedded within the outer scarcely one-third of its diameter. A specimen having a diameter of a little less than four inches possesses three volutions, with room for one or one and a half within the inner one counted, and has a transverse diameter of the outer tube of about one inch and one-tenth. A section of the tube is nearly that of a circle, with a scarcely perceptible flattening on the dorsum, and the ventral channel for the inner whorl on the inside; the lateral and the dorso-ventral diameters, exclusive of the ventral channel, being essentially equal. The shell substance is rather thick, and the surface marked by rather fine lines of growth which are strongly recurved on the sides of the tube from the suture outward, and in crossing the dorsum form a broad linguiform sinus, indicating a deep sinus in the dorsal lip. Septa numerous, and rather deeply concave, arranged at a distance of about a sixth of an inch from each other, near the outer portion of the chambered part of the large specimen figured, when measured on the middle of the side. On the dorsum, of course, they would be a little more distant. Their direction across the tube is generally nearly at right angles to the tube at any given one, though sometimes they are directed more strongly backward from the inner to the outer sides. Siphon small, situated a little outside of the centre of the tube, and apparently very slightly expanded at its junction with the septa, showing a very slight contraction in size between them.

This shell differs from *L. undatus*, Conrad, from the Black River limestone, in the more slender and less rapidly enlarging tube, which is also more closely coiled, the outer volutions embracing the inner; whereas that one is only in contact, not imbedded, or but merely indented one into the other. They also differ in that one being very distinctly flattened on the dorsum, while the flattening here is bearly or scarcely perceptible, neither does this one possess the strong undulations of the surface which is so strong a characteristic of that species. Among the several specimens which I have seen of this species I have observed none showing the deflection of the outer tube, though several fragments of a size somewhat larger than the figured specimen have been obtained. Therefore we may consider that it is capable of reaching a much greater size. The figured example is septate throughout, except the outer half of the last volution, and shows by the fragment of the outer shell adhering, that it has been about one and a half inches longer at the outer end, it follows that the chamber of habitation has been very long, at least two-thirds of the outer volution. The *L. undatus* is not known to possess nearly so long an outer chamber, although I have seen no perfect ones, nor have such been figured. The evidence afforded by the best I have examined would indicate only about one-third of the volution without septa, and the western representative of it *L. occidentalis*, Hall, shows scarcely one-third.

Lituites Eatoni, n. sp.

PLATE 32, FIG. 1, and PLATE 28, FIGS. 5–7.

Shell small, or below a medium size, consisting of about four volutions, which increase very gradually in diameter, and are neatly and compactly coiled, and embrace each other to a depth equal to nearly one-fourth of their diameter, but appearing more deeply imbedded from the tube being dorso-ventrally compressed. The outer coil becomes deflected in a straight line for some distance from the aperture at precisely four turns from the nucleus, and gradually becomes circular in section instead of transversely reniform like the inner coils; the aperture is unknown. Surface of the shell, which is thin, marked by fine, somewhat regular lines of growth, which are gently directed backward from the suture to the rounded dorsum; in crossing which they form a broad shallow sinus, indicating such a form in the lip of the aperture. Septa numerous, and rather deeply concave, between four and five to the half inch on the dorsum a little back of the outer chamber of habitation, near to which they are more closely crowded. Near the suture line they advance very slightly in crossing the volution, then gently recede on the sides and again almost imperceptibly advance in crossing the dorsum. Siphuncle small, situated between the centre of the tube and the ventral margin; its diameter smaller between the septa than at their junction with it, as in *L. Seelyi* herein described.

This is a much smaller species than *L. Seelyi*, and more closely resembles *Trocholites ammonius*, Hall, from the Trenton limestone, but is a much prettier and more graceful species. The shell structure also somewhat resembles that of that species, but is less coarsely marked; the tube is also slightly different in a transverse section, not being so symmetrical on the sides, but more abrupt near the suture and flatter on the sides; the section having its greatest diameter within the central line. The form and features of the septa, and the position of the siphon, are very similar. The great difference, and that which is the soonest observed, is the greater lateral compression of the shell as a whole, which will distinguish them very readily.

Lituites Eatoni var. **Cassinensis,** n. var. PLATE 32, FIG. 2.

In subsequent collections, made since the above was in type, I find a strongly marked variety, which I am not sure ought not to be considered as an entirely distinct species; the section of the tube is much rounder on the sides, giving it a decidedly rounder form on the sides, but it is also very decidedly flattened on the back, and on the outer part of the last specimen is almost concave in the middle. The septa and siphon are much the same as in the typical form, while the surface striæ are slightly coarser than in any of those originally placed under *L. Eatoni*; consequently, I shall designate this for the present as *L. Eatoni* var. *Casinensis*.

Lituites internastriatus, n. sp.

PLATE 29, FIGS. 5-8.

Shell, as yet known, of rather small size, the only specimen which retains the outer chamber being a little short of two inches

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in its greatest diameter, and consists of between two and three volutions. Volutions nearly circular in general outline, being only very slightly compressed in a lateral direction, with a rounded dorsal margin, and scarcely embracing. Outer surface obliquely annulated, the annulations being strongest on the sides, rounded on the surface, and separated by equally wide, regularly concave interspaces. From the inner margin or suture the annulations are directed strongly backward on the side of the shell where they gradually die out and become obsolete or nearly so on the dorsum. Shell substance thick, the suface on the undulations and between marked by strong, almost lamellose striæ, which follow the direction of the undulations on the sides of the shell, while on the dorsum they form a deep retral sinus, indicating a deep sinus in the dorsal lip of the aperture. Interior of the shell throughout, as indicated by the cast wherever the shell is removed, marked by extremely fine, transverse, thread-like striæ, having a direction almost directly across the tube. These, as well as can be counted under a strong glass, will number about thirty in the space of one-tenth of an inch. Septa near the base of the outer chamber, which is at about the middle of the last volution, arranged about a tenth of an inch apart, and apparently rather deeply concave. Siphon comparatively large and situated near the inner margin of the tube.

This species is very distinct from either of the associated ones, especially differing in the surface undulations and striæ. But in the internal striations it differs from any species hitherto observed, so far as I know, even a small fragment of a cast would serve to identify it. The species is much less common than any of the others here described, evidences of only few specimens having yet been obtained. The specimen figured retains a large portion of the outer chamber, and although still in contact with the inner whorl at its extremity, was apparently about to separate to form the deflected portion showing its generic relations with *Lituites*.

ARTHROPODA.

TRILOBITA.

Genus SAO, *Barrande.*

Sao? Lamottensis, n. sp.

PLATE 33, FIG. 9–11.

Body, considered as a whole, elongate-ovate in outline, widest anteriorly and with somewhat straightened sides, the head shield forming about one-third of the entire length.

Glabella, with the fixed cheeks, nearly semicircular in outline, and quite elevated, the dorsal furrows very strongly marked. The glabella, considered alone, forms the larger two-thirds of a broad-oval figure, as limited by the dorsal furrow, and is marked by two pairs of very strong, deep glabellar furrows, the posterior of which is the largest and strongest, and stands nearly parallel to the lateral margin, instead of being transverse; both pair seeming more like deep sharp pits than ordinary transverse furrows, and are confined to the side of the glabella proper. Fixed cheeks very rotund on the surface, rather more than half as wide, on the back part, as the glabella, rapidly contracted to the ocular sinus, and more gradually narrowed anteriorly to the middle of the frontal limb, which is narrow and rounded in front, the anterior margin of the shield being slightly elevated, forming a narrow border. Ocular furrows strongly marked and somewhat deeply sunken, curved in their direction across the fixed cheek. Occipital ring short, rounded, and highly arched but much lower than the surface of the glabella, the lateral portion being shorter and sharply rounded. Suture line cutting the posterior margin nearly at right angles, and gently curving inward in its course to the ocular sinus, which is only of medium size. In front of the sinus it is directed gently inward cutting the anterior border nearly on a line with the sides of the glabella. Surface of the glabella and fixed cheeks pustulose, the pustules of various sizes. There are six large pustules on the glabella proper, three on each side, and three on each fixed cheek, two behind the ocular ridge and one in front; over the rest of the surface the pustules are irregularly scattered and are of smaller size. A single *Hypostoma* has been observed of a size suitable to the head shields. It has a great resemblance to that of *Conocephalus*, and is quite similar to that of *Sao hirsuta*, as shown by Barrande in Vol. 2, Syst. Sil. de la Boheme, Pl. 7, fig. 21, but the central part is more distinctly ovate and the border narrower.

Movable Cheeks not yet observed.

Thorax widest at the anterior end and almost gradually narrowing backward to the minute pygidium ; twelve segments only have been observed, although more may occur in larger individuals, the largest one examined measuring scarcely six-twentieths of an inch as the length of the thorax alone. Axial lobe wider than the lateral lobes, very strongly arched; lateral lobes entirely flat to near their extremities. Segments marked on the central ridge by several nodes on each side of the lateral portions and the axial lobe bearing a central row of many very prominent nodes. The extremities of the pleura are short and pointed and directed slightly backward.

Pygidium minute, its details not made out.

The species as yet known is rather small, none having the entire organism complete have yet been successfully cleared from the rock ; but taking the length of the best thorax and that of a glabella of equal proportions, the length combined is only nine-twentieths of an inch, with a width of five-twentieths for the upper end of the thorax. There is no certainty that the thorax taken is complete, therefore the number of segments that may exist is not definitely known, but there appears to be no reasonable doubt of its completeness. The species differs considerably from *Sao hirsuta*, Barrande, from Bohemia, in what might be considered as generic features, but as that one is about the only authentic species yet known it is difficult to say what the generic features may be. I know of no established genus which it so nearly resembles as *Sao*. The next nearest might be *Acidaspis*. In the structure of the pleura this species differs quite remarkably from *S. hirsuta*, being between that and *Acidaspis*, having a central ridge, which becomes obsolete, however, on the outer portions; also it differs in the backward bending and pointed structure of their extremities.

Since writing the above, larger heads have been obtained, some measuring fully three times the length of that mentioned.

Formation and locality.—The species is extremely abundant in some dove-colored layers of the Birdseye limestone from Isle La Motte, Lake Champlain, but the head shields are all separated from the other parts and appear scattered through the limestone in great numbers.

Genus ASAPHUS, *Dalman*.

Asaphus canalis.

PLATE 34, FIGS. 1–8.

Isotelus canalis, Conrad, in MS.

Isoteles canalis (Conrad), Hall, Pal. N. Y., Vol. 1, p. 25, Pl. 4 bis., figs. 17–19.

Asaphus canalis (Conrad), Hall, 12th Rept. State Cab., p. 70.

Not *A. canalis*, Billings, Pal. Foss. Can., Vol. 1, pp. 270 and 352.

? *Isoteles gigas*, Hall, Pal. N. Y., Vol. 1, p. 25, Pl. 4 bis., figs. 15 and 16.

? *Asaphus ? obtusus*, Hall, Pal. N. Y., Vol. 1, p. 24, Pl. 4 bis., fig. 14.

Not *Asaphus canalis*, Hall, 12th Rept. State Cab., p. 70, where reference is given to pp. 231 and 254 of Pal. N. Y., Vol. 1.

In Vol. 1, Palæont. New York, p. 25, Pl. 4 bis., figs. 17–19, Prof. J. Hall cites this species from MS. of Mr. T. A. Conrad's, and gives the following description: "Margin of caudal extremity broadly and deeply depressed, forming a channel; surface punctured. Judging from this fragment, the original was at least six inches in length."

It is to be presumed that the fragment above referred to is that of the thickened marginal rim of the pygidium, figured on Plate 4 bis, of Vol. 1, Pal. N. Y., which is of a species quite common in the Chazy limestone at Chazy and elsewhere on Lake Champlain, and also in the limestones above the Chazy. In the Birdseye limestone at Fort Cassin, Vt., fragments of it are quite numerous, especially of these thickened parts of the pygidium, and often of a size nearly double that of the one figured by Prof. Hall. The entire pygidial plates are occasionally found, most frequently those of small size and rarely of larger size. Fragmentary movable cheeks of large size are also occasionally seen, especially the posterior spinose angle, which is much thickened, and has, therefore, been more readily preserved. Parts of the central portions of the head have been observed in a few instances, but rarely in a condition fit for illustration; but the thoracic segments are seldom seen in a condition for identification, and as yet none have been found fit for illustration. The characters of the parts obtained in a condition suitable for study may be described as follows:

The *head shield* appears to have been less pointed than that of *A. gigas*, as the front of the glabella has been bordered by the movable cheek to near the median line, and in this species is pointed in the center and somewhat excavated on each side, presenting a strong contrast between it and the form of the same part in that species. The central part of the glabella or boss is quadrangular in outline, rounded in front, and slightly constricted across the middle on a line with the eye lobes. In the young individuals the quadrangular form is very marked and the median line slightly angular, with a small node just in front of the occipital furrow in the cast. The larger glabellas show also a depression on the median line near the front and between the eyes, as shown on two separate examples. The anterior limb of the glabella is rather wide and slightly concave on the surface, the lateral edges being rounded, the line of the facial suture passing inward to the anterior angle of the eye. Palpebral lobe moderately large and slightly elevated, reniform on the ocular margin. Postero-lateral limbs short-triangular, but wider than long, the sutural margin, from the posterior angle of the eye lobe to the posterior margin of the head, forming a sigmoidal line having a general angle of a little less perhaps than forty-five degrees to the median line of the head.

Movable cheek rather large, elliptically triangular in general outline, narrow in proportion to the length, projected backward at the angle into a long strong spine; the anterior limb is also extended; general surface concavo-convex, the margin being broadly concave and the inner area convex, without special limitation between. Ocular sinus of moderate size. In the young specimens the outer margin is somewhat rounded or thickened, but on the larger examples they are very slightly so, but are thick and round on the under surface, like the under margin of the pygidial plate; the thickening of the spine being principally on the under surface.

Hypostoma large, oval in general outline, straight or slightly emarginate on the articular border, strongly contracted a little below the top, and deeply excavated between the forked branches, which are thin and deep. Central body highly convex, ovate, widest in front, and margined by a curved fold on each side at the lower end. Lateral borders thin, broad, and the margins strongly arched outward, extending from the anterior constriction, which is near the front, to the extremities of the forked branches. Surface very strongly striate.

Thorax unknown.

Pygidium large, semicircular or paraboloid in general form, obscurely trilobed and only moderately convex, with a very broad, shallow channel occupying the outer half of its area; anterior margin nearly straight. Axial lobe narrow and obscurely marked, widest anteriorly, depressed and narrow just in front of the middle and more prominent and rounded toward the extremity; marked by eight or nine obscure annulations exclusive of the terminal ones. Lateral lobes marked by a single groove just behind the articular face of the anterior border, and in the very young specimens by several very indistinct segments just outside of the very faint dorsal furrows.

The thickened marginal rim of the tail, when viewed from below, is seen to be much broader on the sides than on the posterior median line, which gives it a somewhat V shape as seen from this side, presenting the form given in Vol. 1, Pal. N. Y., Pl. 4 bis, fig. 17, though not as extreme as there represented, unless by distortion.

Surface of the crust generally smooth, the margin of the pygidial plate when perfect shows the peculiar striations common to trilobites. Other parts show, sometimes, a roughening, owing to a kind of maceration or erosion in the strata.

In the 12th Rept. State Cab., p. 70, *Isoteles gigas*, described on pp. 25, 231 and 254 of Pal. N. Y., Vol. 1, are referred to *Asaphus*

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canalis. On what grounds is not stated. *A. canalis* is certainly a very distinct species from those indicated, except that on p. 25, which is most probably a young *A. canalis.* The two species differ very materially in the particulars pointed out at the head of this description, in the form of the glabella and fixed cheeks, while the movable cheeks differ in the large strong spine of the genal angles. It also differs in the direction of the facial suture, particularly in front of the glabella, where it carries the movable cheeks further forward on the upper surface, and gives them a greater breadth across the extended limb. *A. gigas* never possesses the broad shallow channel around the head and tail possessed by this one, and they also differ very materially in the outline form of the tail piece, as well as in the breadth and form of its axial lobe. The large form of *Asaphus*, described as *A. megistos* by Dr. Locke, from the Cincinnati beds of Ohio, corresponds much better with this one in many particulars than do any of the New York Trenton specimens, as that one has the broad channel of the tail piece, and the same form of the axial lobe, and indistinct annulations. The head, however, differs in the direction of the facial suture, in the form of the glabella, and in having the cheek spines narrow and nearly cylindrical, even up nearly to their origin. The hypostoma also differs as does that of *A. gigas.* Considering these facts, I think there can be no question but that *A. canalis*, as identified in Vol. 1, Pal. N. Y., and in this paper, is a good and valid species.

Genus BATHYURUS, *Billings.*

Bathyurus ? Seelyi, n. sp.

PLATE 33, FIG. 12–18.

Body, as indicated by the central portions of the head and movable cheek, of moderately large size, but only known from these detached portions, unless the pygidium described below shall prove to belong with it.

Glabella large, ovate, inflated and protruding anteriorly, somewhat constricted just in front of the occipital ring, where it is less rounded and less convex than in front, apparently marked by a single pair of slight furrows a little forward of the occipital furrow, making a band across the posterior part of the glabella not quite as wide as the occipital ring. No other furrows are known to exist on its surface. Near the base of the glabella, between the occipital ring and the palpebral lobe, there exists a rather large auxillary lobe on each side, like those of *Cyphaspis*, *Proetus*, etc., of a somewhat reniform shape, and which at their anterior end blend into the palpebral lobe without a distinctly defined channel between.

Fixed cheeks narrow, especially just in front of the eye lobe, anterior to which they are abruptly widened and again narrowed in front, forming a rounded lobe of nearly the same size and form as the eye lobe, which is proportionally large considering the width of the cheeks. Posterior to the eye lobe the cheek is narrowed, forming a deep and sharp sinus in the outline, from which the postero-lateral limbs run obliquely outward, constantly narrowing to a length equal to two-thirds of the width of the glabella, as measured along the occipital ring. Occipital furrow fairly well marked across the base of the head, especially so along the lateral limbs. Anterior limb narrow and vertical, entirely overhung by the anterior lobe of the glabella.

Movable cheek of moderate size, having a tumid, convex surface, especially of the marginal rim, which is very narrow in front and vertical, and is less elevated but gradually widens backward to the genal angles, which terminate in a short, sharp spine. Ocular sinus large, semicircular.

Thorax unknown.

Pygidium found associated with the head and movable cheek, and believed to belong to the same species, nearly semicircular in form, or very slightly paraboloid and highly convex, very strongly marked by the furrows between the rings of the lateral lobes. Axial lobe rather prominent; about three-fourths as long as the whole length of the entire shield, and rather more than one-fourth of the greatest width; marked by four transverse rings, besides the terminal one, the anterior of which bears a small distinct node on its center. Lateral lobes convex for the inner two-thirds of their width, outside of which there is a rather wide, smooth, concave border, but which is slightly rounded just at the edge. These lobes are marked by four pairs of lateral ribs, besides the anterior one. These ribs originate at the dorsal furrow as four on each side, but almost immediately divide into an anterior narrow and a posterior broad portion, the former terminating in a narrow point, and the latter widening at the extremity, becoming triangularly clavate at its outer end, terminating at the margin of the broad, concave border of the plate. On the lower surface of the pygidial plate the marginal portion, or "doublure," is entirely flat, and as wide as the concave, smooth space above.

Surface of the pygidium, movable cheeks and a large part of the head is finely pustulose. On the glabella, at least the anterior portions and sides, and the anterior part of the fixed cheeks in front of the eye lobes, the pustules pass into wavy lines more or less distinct, with fine, deep punctæ scattered between them.

I have provisionally placed this species under Mr. Billings's genus *Bathyurus* as being perhaps the most nearly allied genus yet established, not feeling at liberty to propose a new generic division until better material shall have been obtained. There are many features in which it differs from *Bathyurus*, principally however in the overhanging anterior end of the glabella; in the auxiliary lobes at the posterior angles of the glabella; in the direction of the suture line in front of the eye, and consequent form of the anterior fixed cheek and frontal limb of the glabella, and very markedly in the peculiar form and division of the lateral rings of the pygidium. In the form of the inflated glabella and auxiliary lobes it closely resembles *Cyphaspis*, but all similarity ends here. In the lobation of the lateral rings of the tail it somewhat resembles Salter's subgenus *Homalopteon* under *Barrandia*, McCoy, but the head differs entirely. To be sure there is no positive evidence as yet that these pygidia and heads here associated belong together, but as they are found in the same layer of rock, and the surface structure of the crust is the same on the fixed cheeks, movable cheek and tail; and as there is no other form associated with them to which these parts can be referred, it may be taken as presumptive evidence of their close relationship. There is a small *Bathyurus-like* head associated with them, which is highly pustulose, but of which the largest head is far too small for the smallest of these tails observed; while the specimens furnishing the measurements for the figure presented, is only about two-thirds as large as the largest one used. *Asaphus canalis*, Conrad, is the only other large species associated with it, but as all parts of it are known except the thoracic segments, no question can remain regarding it.

In an extract of this paper, distributed in August last, this species was mentioned in the remarks on the second page of the article as *Bathyurus extans*, Hall's species. That identification was based upon a very imperfect pygidium of small size. Subsequent collections, however, yielded better and larger examples, as well as other parts of the organism, proving the identification incorrect.

Genus LICHAS, *Dalman.*

Lichas Champlainensis, n. sp.

PLATE 33, FIGS. 6–8.

Species known only by the pygidial plate, which is of very fair size, transversely elliptical in general outline, very moderately convex, with a short, highly elevated, and subtriangular axial lobe, which at its anterior end is fully one-third of the entire width of the plate; its form from the anterior border backward is moderately narrowed for about half its length, then more rapidly narrowed to an elongated acute point at some distance within the posterior margin. The lobe is crossed by two very distinct furrows and two indistinct ones, forming four axial rings besides the terminal one. The lateral lobes are marked by two linear furrows on each side which are reduced to simple, impressed, almost thread-like lines, strongly inclined backwards with an outward curvature in their direction toward the margin. The anterior border is short in front and rapidly curved backward at the sides, the surface of the whole nearly flat between the furrows. The margin, which is imperfect, appears to have had two points on each side, besides the central plate or lobe; which also has the appearance of having been slightly notched in the middle. This however is somewhat uncertain. The entire surface of the plate is marked by fine pustules which are mostly triangular in form with the point directed backward, presenting a scaly appearance.

Formation and locality.—In the Birdseye limestone at Isle La Motte, Lake Champlain.

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PHYLLOCARIDÆ ?

Genus RIBEIRIA, *Sharp.*

The genus *Ribeiria* was described by Mr. Sharp at first under the supposition that it was a univalve shell, belonging to the *Calyptreidæ.* The objects have much the appearance of bivalve shells, but seem to have been considered as univalves principally from the position of the muscular imprint, which extends across the dorsal portion ; and from the occurrence of an internal plate which seems to divide the anterior end a little below the dorsal angle, forming a notch in the internal cast. This notch when taken in connection with the deeply impressed muscular scar, and considered as an evidence of a slightly projecting internal muscular plate, like that of many forms of the *Calyptreidæ*, certainly looks in the cast of the type species as if it were the remains of a laterally compressed form of a species of that group of shell; while the exterior of the same species would just as readily pass for a bivalve shell, either of the *Crassatellidæ* or *Nuculidæ.* Mr. Billings, of the Canadian Geol. Survey, in his Pal. Foss. Vol. 1, p. 340, figures two additional species of the same group, which he refers doubtfully to Sharp's genus under the provisionally new generic name *Ribeirina*, but places them under unclassified forms, evidently being in doubt as to their true systematic position. Mr. Billings states in his observations on those bodies, that he thinks Mr. J. W. Salter has referred the genus *Ribeiria* to the Crustacea, but says he has not been able to see the publication. I have searched through all the articles of J. W. Salter's which I can find published between the dates of Mr. Sharp's original description (1853), and that of Mr. Billings's statements (1865), but can find no reference whatever to Mr. Sharp's genus. Still I may have overlooked one. I think there can be no question about their relationship to the *Ceratiocaridæ* (or *Phyllocaridæ*, if we adopt Prof. Packard's new name), and shall consider the two following species under that light. The two species evidently belong to two different sections of the genus, like those described by Mr. Billings, loc. cite., the one being thin and compressed, with a nearly straight dorsal margin, and the other full and gibbous with prominent umbos like a nuculoid shell. Still both forms have the muscular markings situated along the dorsal margin ; and although they are symmetrically placed on the opposite side of the ridge, there is no evidence of a median separation, as would be the case were they shells of bivalve Mollusks. Nor is there any evidence of any hinge, or any separations of the valves, even as would be the case in *Leperditia* and its allies, but on the contrary the shell appears to have been simply bent over along the dorsal line, and to have been continuous, or composed only of a single piece, while the muscular scars are situated exactly on the median line.

Ribeiria compressa, n. sp.

PLATE 33, FIGS. 3–5.

Carapace small and very much compressed laterally, about three-fifths as high as long, having an oblong or suboval outline, somewhat straightened on the dorsal margin, and with the sides very depressed convex. Antero-dorsal extremity, in the cast, pointed, with a notch below it, leaving the extremity more sharply rounded than the width of the valve would indicate were the substance of the carapace itself preserved, the pointed beak-like projection not extending as far as the rounded extremity below. Notch nearly an eighth of an inch in depth, and with a broad, shallow depression passing obliquely backwards from the end. Muscular scar narrow, situated on the rounded dorsal edge, and extending nearly two-thirds the length of the carapace. Anterior and posterior extremities both slightly gaping, the latter most conspicuously so. Surface smooth so far as can be determined from the casts.

This species somewhat closely resembles *R.? longiuscula*, Bill., Pal. Foss., Vol. 1, p. 340, fig. 327, but is more distinctly oval in outline, less straightened on the dorsal margin, and not at all sinuate in the median ventral region.

Ribeiria ventricosa, n. sp.

PLATE 33, FIGS. 1 and 2.

Carapace small, the largest and most perfect specimen yet noticed being a little less than three-fourths of an inch in length, by less than half an inch in height, and nearly three-eighths of an inch in thickness, being a cast of the interior from which nearly all the shell has been removed. The general appearance is that of a nuculoid shell of small size, with prominent, subcentral beaks, and with the valves oppressed both anteriorly and posteriorly, and the apparent hinge line considerably below the very prominent umbones. The anterior end of the carapace is narrowly rounded, slightly gaping, and having the longest point a little above the median line, and in the cast shows the marginal surface marked by ten or twelve slight transverse pits, showing the interior of the gaping end of the carapace to have been crenulated. From the anterior end, the basal margin is gradually receding obliquely backward, and the valve widening for two-thirds the length of the carapace, and is then rounded upward to the longest posterior point. On the median dorsal line, between the umbones, is situated a round elevated tubercle, which either marks an opening or a deeply sunken muscular scar, while a second similar one is situated about half way between the umbones and the posterior end, still on the median line; and between it and the umbones occurs an elevated, narrow, cordiform muscular scar. The dorsal line shows no evidence of a ridge marking the junction of two valves, as would be the case in a bivalve shell, but is smooth and regularly depressed, except on the thin anterior projection, where it is narrowly rounded, as if the covering had been continuous and simply bent over.

The casts of this species bear some distant resemblance to *R. ? calcifera*, Bill., Pal. Foss., Vol. 1, p. 340, figs. 326, *a*, *b* and *c*, but is more gibbous and less elongated behind, with much more prominent beaks.

One feature noticed on the casts of this species, is that the remains of the substance of the carapace of these bodies where preserved is crystalline, and does not present that homogeneous character common to fossil crustacean remains.

Note.—An extract of this paper, containing only a portion of the species here described, was distributed in August last. Since then large collections have been added, and the results here imbodied.

ARTICLE XVIII.—*Notice of a new fossil body, probably a sponge related to Dictyophyton.* By R. P. WHITFIELD.

In the spring of 1876, I obtained from the slates at Kenwood, near Albany, New York, at an outcrop not more perhaps than forty or fifty feet from the layer which contains the Utica slate graptolites, a number of fossil bodies, which, although much resembling plant remains in their general form and fragmentary condition, still possess almost too definite a structure and too much substance for any known form of fossil fucoid of that period. The specimens are of all sizes, from a diameter of a fourth of an inch to that of the largest one figured on Plate 35 of this Bulletin, which is three and three-quarter inches in its greatest breadth. The substance of these fossils is a thin, pyritous film, seldom exceeding a thirtieth of an inch in thickness, and often scarcely possessing an appreciable thickness. The substance is made up of two or three sets of bars or rods, the principal ones of which are straight, rigid, and apparently cylindrical; although as yet I have been unable to isolate any one of them from the surrounding substance. The rods are arranged at varying distances from each other, from being nearly in contact to about a sixteenth of an inch apart. They are usually finer and more slender near the margin of the body. Crossing these at various angles, other than at right angles, and usually quite oblique to the primary series, is a second set, arranged very much closer and of finer texture, as well as usually much more flexible. Apparently a third still finer series crosses both of these, whereby the interspaces become interwoven and filled, forming a textile pattern very closely resembling the surface of Turkey Morocco leather, although somewhat more regular. The margins of the fronds, as well as spots of considerable size over the discs, and often nearly the entire surface of many of the smaller specimens are smooth, with a semi-polished surface, closely resembling that known as "slickensides," but when examined with a lens even these surfaces are seen to be underlaid with the same structure, but of very fine texture. As stated above, the substance is usually pyritous, and the pyrite is often gathered into small globules or aggregations of globules; but the edges of the discs or fronds are usually thin, and the rods

[*Dec. 28th,*

very slender or obsolete. I am somewhat at a loss to know whether to consider these bodies as of animal origin, and closely related to the *Dictyospongidæ*, or to refer them to the vegetable kingdom, classing them near the marine fucoids. They seem unlike vegetable remains on account of the rigid nature of the frame work, and their pyritous remains; while the carbonaceous, smooth, filmy structure and shapeless form is somewhat plant-like. I am more strongly inclined to believe, however, that they will prove to be of animal origin, and related to *Dictyospongidæ*. For these bodies I propose the new generic name *Rhombodictyon*, in reference to the rhombic character of the spaces formed by the different sets of rods forming the net work of their substance.

Rhombodictyon, n. gen.

Globular, discoid or broadly cyathiform fossil bodies, composed of two or more sets of more or less rigid rods or threads, crossing each other at various angles, but not bifurcating or dividing, and leaving rhombic spaces which are filled with carbonaceous or other substance. Type *R. reniforme*, Whitf.

Rhombodictyon reniforme, n. sp.

PLATE 35, FIGS. 2–7.

General form of the body reniform, discoid, possibly in the living state broadly cyathiform, substance in all the examples known pyritous, and of not more than a thirtieth of an inch in thickness, often much thinner; rods or threads very distinct and long, the principal set being rigid and arranged at distances of from a sixteenth of an inch to less than a fiftieth of an inch apart, and always oblique to the apparent axis of the frond. Secondary rods thread-like and somewhat flexuose, very much finer and more closely arranged than the primary set, and at various angles from fifty to eighty degrees, but never yet observed at right angles to the primaries. A third still finer set of threads is arranged at still different angles, giving a finely net-like structure. Toward the edges of the frond the rods become more slender, and often more closely arranged from the intercalation of other individuals, but none are seen to bifurcate.

Var. rhombiforme. PLATE 35, FIGS. 8–9.

Very many small individuals are found scattered over and through the shale, varying in size and form, but many, perhaps the greater number, being rhombic in outline, with the threads running sometimes across the shorter diameter and as often parallel to one of the longer sides of the specimen. These may possibly be only fragments of the larger specimens broken up, or may possibly be young individuals; but they do not have that appearance, as the rods all become indistinct before reaching the margins. For this I suggest the varietal name *rhombiforme.*

Rhombodictyon discum, n. sp.

PLATE 35. FIG. 1.

Frond small, discoid, with strong and very distinct rods or threads, arranged about as in *R. reniformis*, substance comparatively thick, in the type example having been pressed into the shale so as to imbed the edges. Diameter of the only individual observed, about one inch.

I am strongly inclined to think this species was globular during life, and that what we see preserved is only the flattened frame work of the specimen.

All the specimens I suppose to belong to the same geological formation, as the *Graptolites* of Kenwood or Norman's Kill, Albany County, N. Y., described in Vol. 1, Pal. N. Y., and in the 12th, 13th and 20th Reports on the New York State Cabinet, from that locality, namely, the Utica Slate: as they are found in a layer of shale but a few feet from an outcrop of that Graptolite-bearing stratum.

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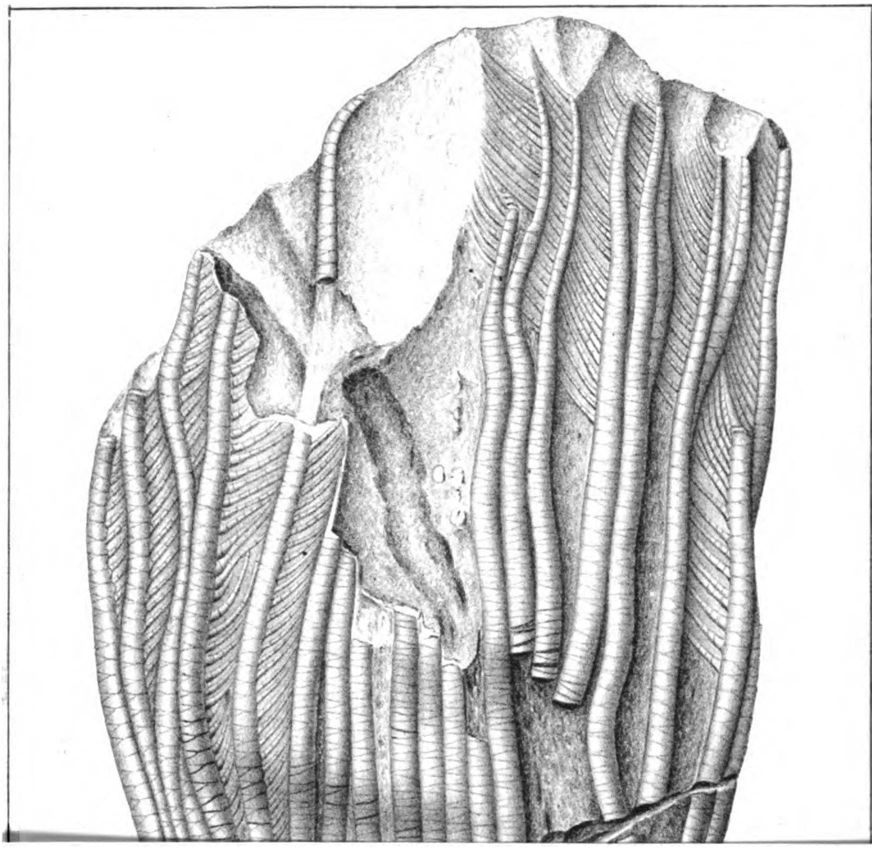
EXPLANATION OF PLATE 1.

POTERIOCRINUS JESUPI. Page 7.

View of the anal side of a specimen, showing the anal series of plates and base of proboscis.

POTERIOCRINUS JESUPI.



EXPLANATION OF PLATE 4.

UPHANTÆNIA DAWSONI. Page 16.

Fig 1. View of the original specimen on which the spiculæ were first discovered.

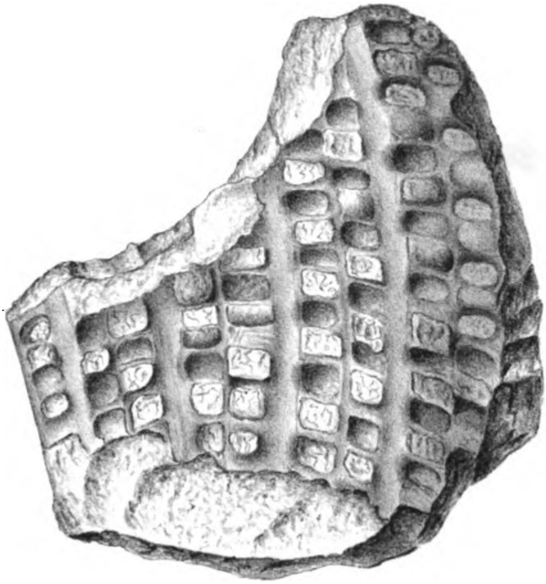
Fig. 2. View of a second specimen of more cylindrical form.

DICTYOPHYTON CYLINDRICUM. Page 19.

Fig. 3. View of the fragment described, the spiculæ on which are remarkably distinct.

FOSSIL SPONGES.

1



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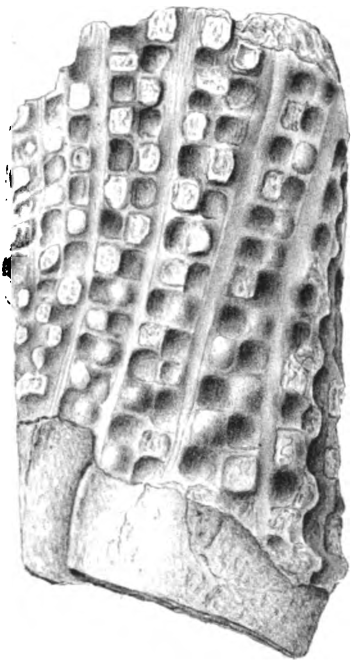

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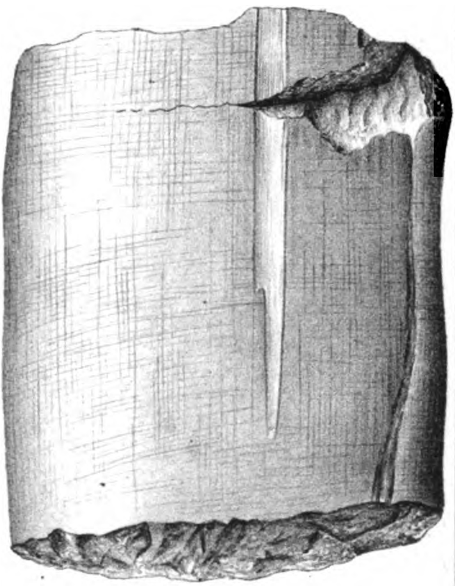

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EXPLANATION OF PLATE 5.

LYMNÆ MEGASOMA. Page 29.

Fig. 1 View of the adult parent shell from Vermont.

Fig. 2. Shows the form of the animal when feeding on the surface of the glass of the aquarium.

Fig. 3. Shows the animal when in motion on the bottom. The opening of the pulmonary sac is shown as extended when breathing.

Fig. 4. Shows the form of the head when in rapid motion, and fig. 5 the same when at rest.

Fig. 6. Outline view of a shell of the second generation.

Fig. 7. Outline of one of the third generation.

Fig. 8. Outline of the individual of the fourth generation which produced living offspring.

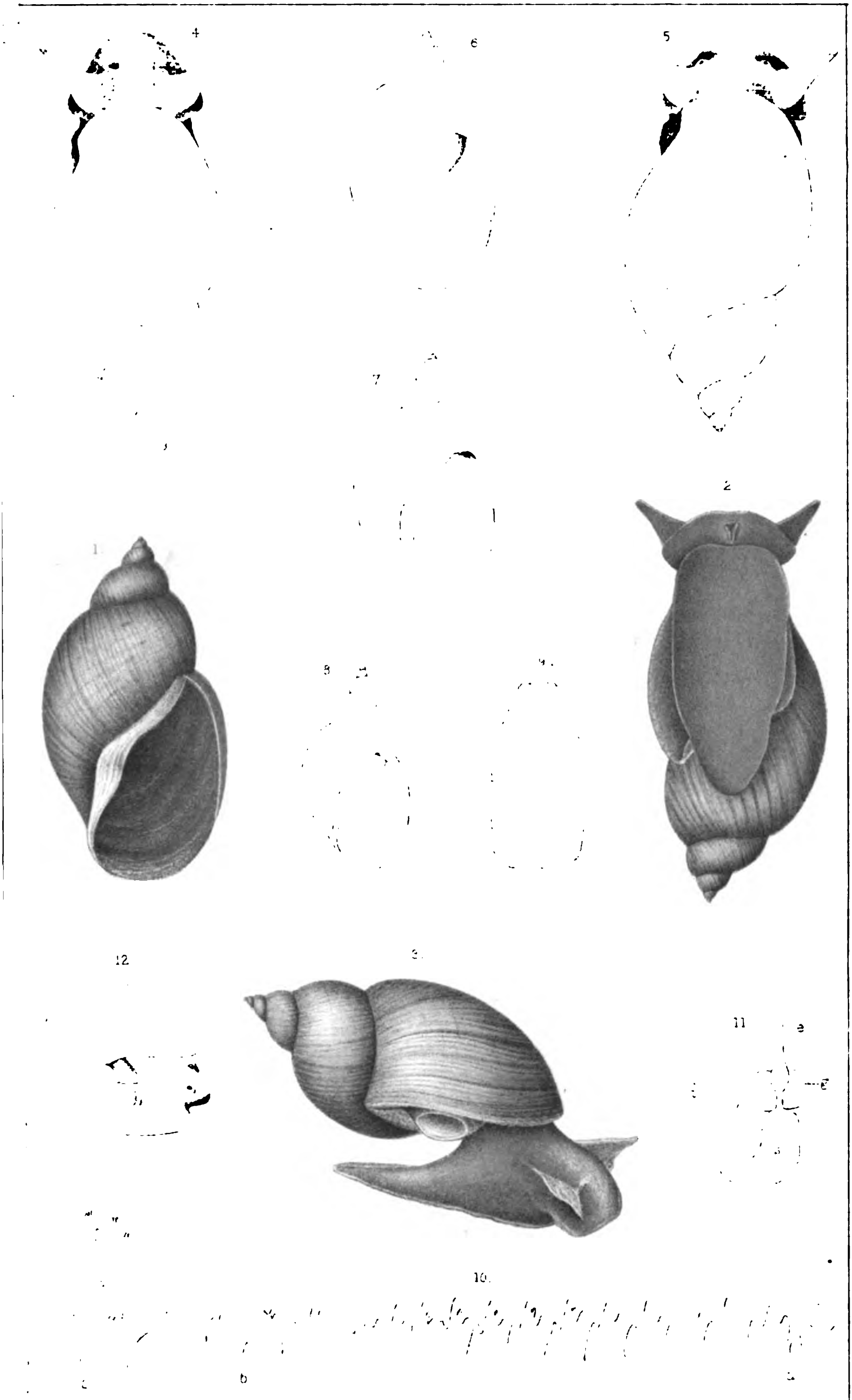
Fig. 9. Form of the lingual membrane, enlarged to six diameters.

Fig. 10. Represents parts of the denticles of the left side of a mature transverse row ; *a* marks the central granule and the denticles of the central section ; *b* and *c* show the varying form of those of the lateral section, and *d* shows four of the marginal section.

Fig. 11. Outline of the stomach, natural size ; *e*, œsophagus with its expansion below at the opening of the gizzard *g* ; *s*, stomach ; *i*, intestine.

Fig. 12. Shows the form and appearance of an embryo the day before its escape from the nidamentum.

LYMNAEA MEGASOMA.



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EXPLANATION OF PLATE 6.

PA

Figs. 1–5. ORTHIS DUBIA, Hall. Fig. 1, dorsal view of a ventricose specimen from Bloomington, Ind. Figs. 2–4, three views of a larger specimen from Spergen Hill, Ind. Fig. 5, interior of ventral valve of a large individual from Paynter's Hill.

Figs. 6–7. PRODUCTUS INDIANENSIS, Hall. Profile and vertical views of the largest type specimen (2x).

Figs. 8–12. PRODUCTUS BISERIATUS, Hall. Fig. 8, enlarged (2x) view of interior of dorsal valve, from Bloomington. Fig. 9, another nat. size from Alton, Ill. Figs. 10–12, three views of a large specimen from Spergen Hill, from later collections.

Figs. 13–15. SPIRIFERA BIFURCATA, Hall. Fig. 13, view of the original specimen, (6x). Fig. 14, a larger individual (3x), and 15, a still larger one (2x) from Spergen Hill.

Figs. 16–17. SPIRIFERA NORWOODANA, Hall. Dorsal and front views of one of the types (3x), from Alton, Ill.

Figs. 18–21. ATHYRIS HIRSUTA, Hall. Fig. 18, a small Spergen Hill specimen (2x), showing setæ; 19–21, three views of a larger specimen from later collections at the same locality.

Figs. 22–27. ATHYRIS TRINUCLEA—*Terebratula trinuclea*, Hall. Figs. 22 and 23, views of two specimens from Bloomington, showing variation of form; 24–27, views of a larger specimen more recently obtained from Spergen Hill.

Figs. 28–30. EUMETRIA VERNEUILIANA—*Retzia Verneuilana*, Hall. Fig. 28, view of a specimen (2x), from Spergen Hill; fig. 29 is from a specimen more recently obtained from Paynter's Hill, Ind.; fig. 30, enlargement of hinge from one of the originals.

Figs. 31–34. RHYNCHONELLA GROSVENORI, Hall. Figs. 31 and 32, views (2x) of a large rotund specimen, 33 and 34, of a smaller one (3x), from Bloomington, Ind.

Figs. 35–39. CAMAROPHORIA WORTHENI—*Rhynchonella Wortheni*, Hall. Figs. 35–38, four views (2x) of the type specimen showing strong plications, and 39, of one (2x) showing a different form of plication.

Figs. 40–42. RHYNCHONELLA MACRA, Hall. Three views (2x), of a large specimen from Alton, Ill.

Figs. 43–45. RHYNCHONELLA MUTATA, Hall. Fig. 43, dorsal view of a specimen of medium size, 44 and 45, dorsal and front views of a large one. Alton, Ill.

Fig. 46. RHYNCHONELLA RECINULA, Hall. Dorsal view (6x) of one of the originals from Spergen Hill.

Figs. 47–49. RHYNCHONELLA SUBCUNEATA, Hall. Dorsal, ventral and profile views of a specimen from Bloomington, Ind.

Figs. 50–52. CENTRONELLA CRASSICARDINALIS, n. sp. Exterior, interior and profile views of a separated ventral valve of a specimen from Spergen Hill, Ind.

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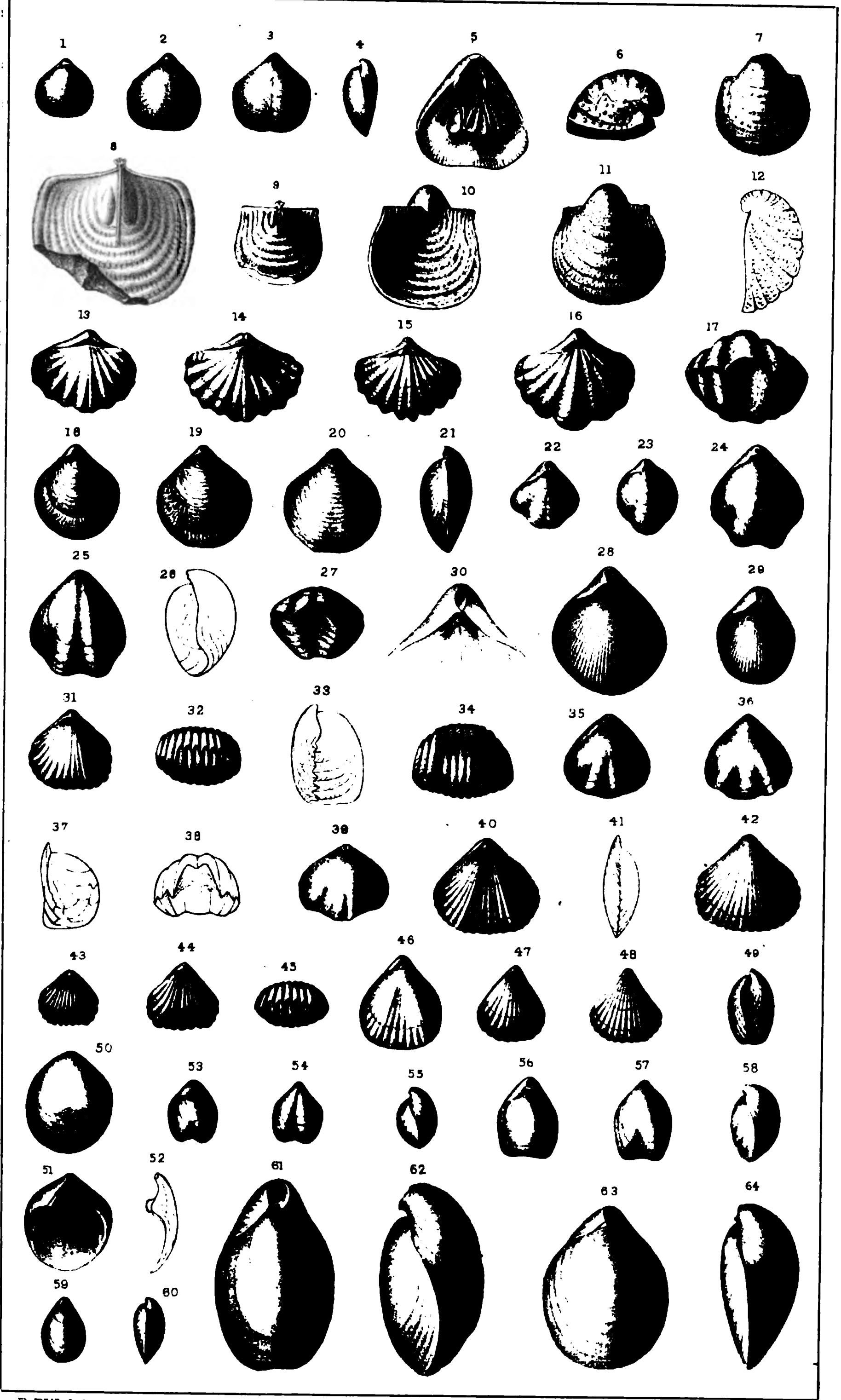
SPERGEN HILL FOSSILS.

(Brachiopoda.)



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EXPLANATION OF PLATE 7.

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Figs. 21–23. CONOCARDIUM MEEKANUM, Hall. Three views (3x) of a specimen from Alton, Ill.

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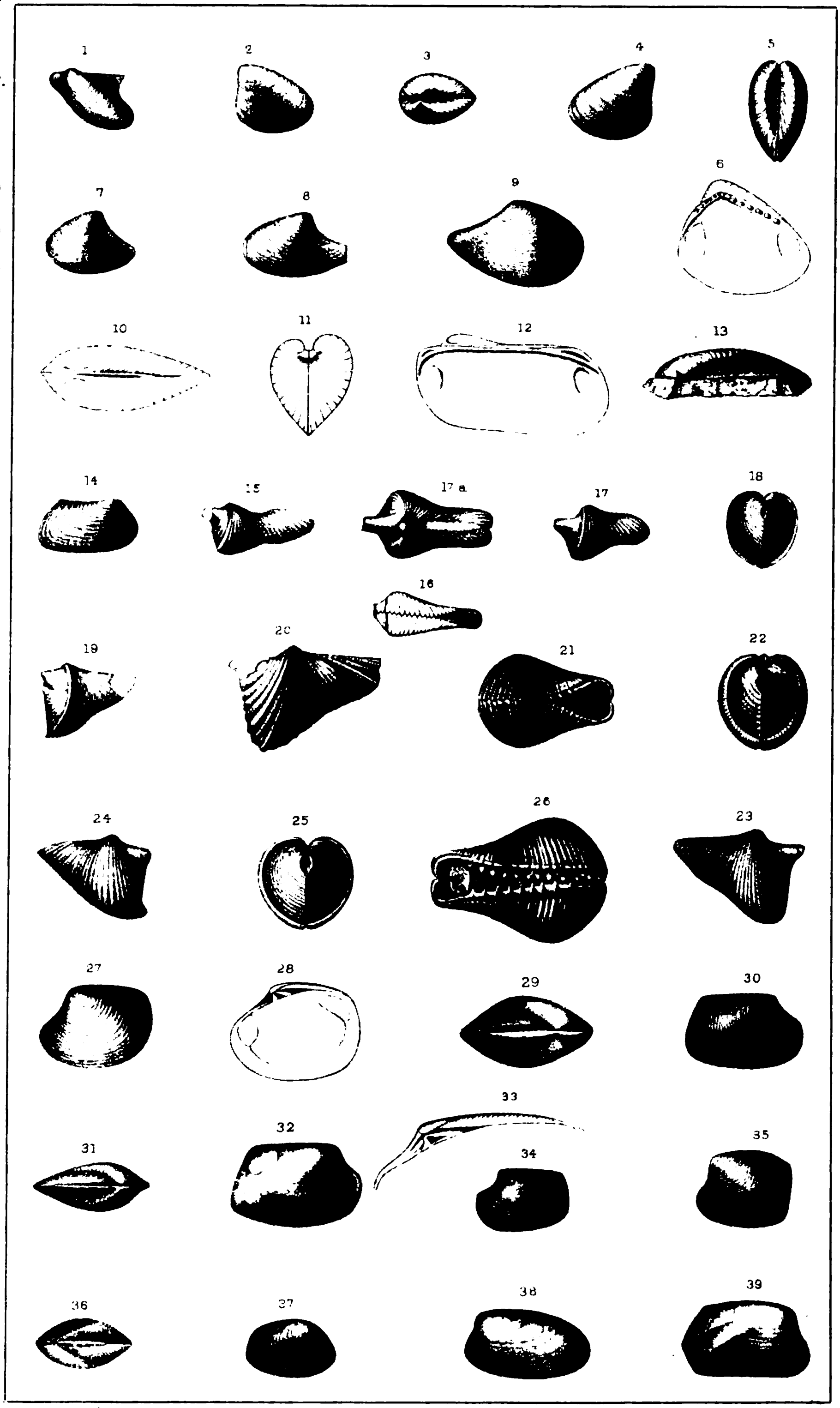
Fig. 39. GONIOPHORA (?) PLICATA—*Cypricardella plicata*, Hall. Lateral view (3x) of one of the original specimens.



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EXPLANATION OF PLATE 8.

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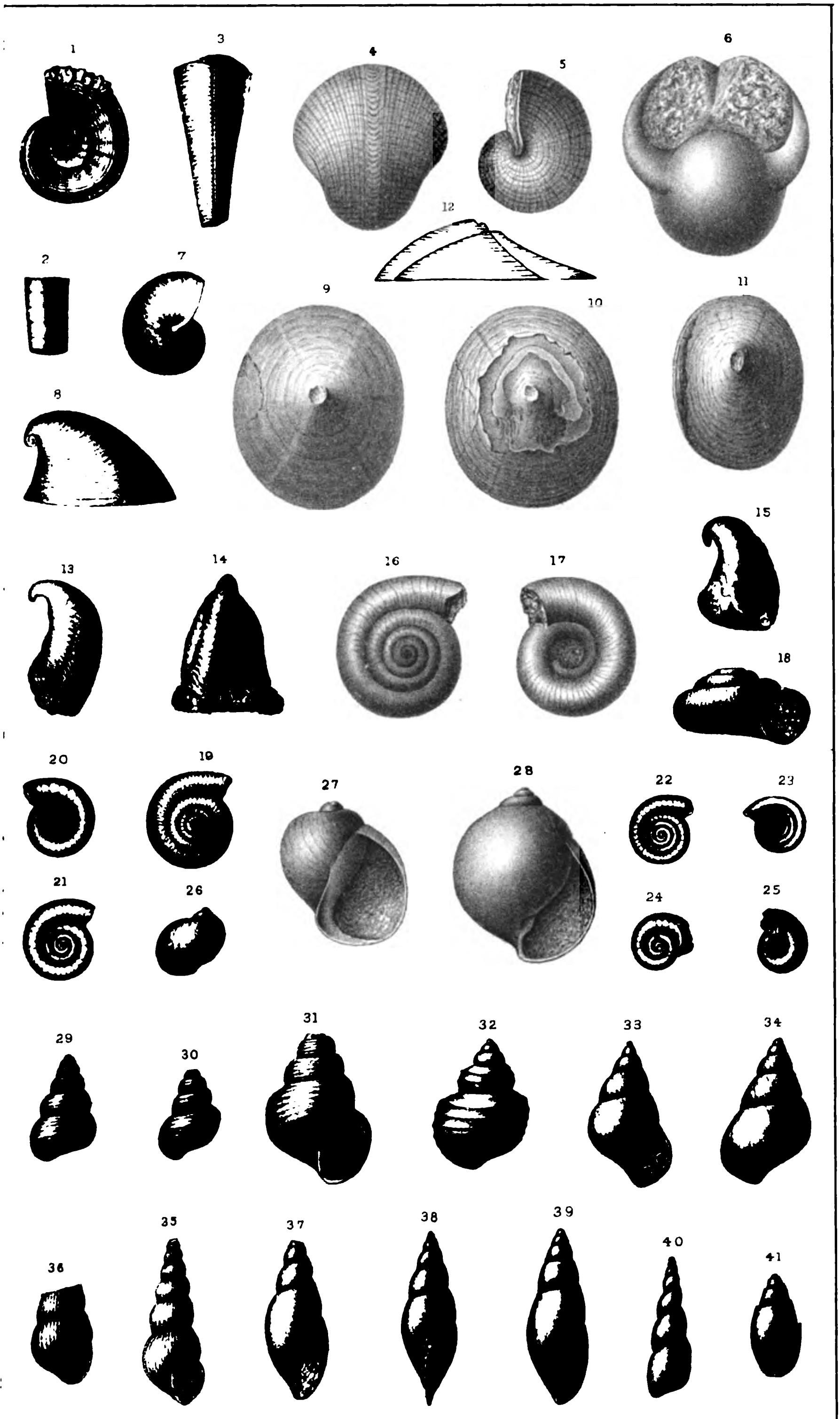

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EXPLANATION OF PLATE 9.

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Fig. 32. Pentremites conoideus, Hall. Lateral view of a specimen, nat. size, Spergen Hill. For other figures see Geol. Rept. Iowa, 1858.

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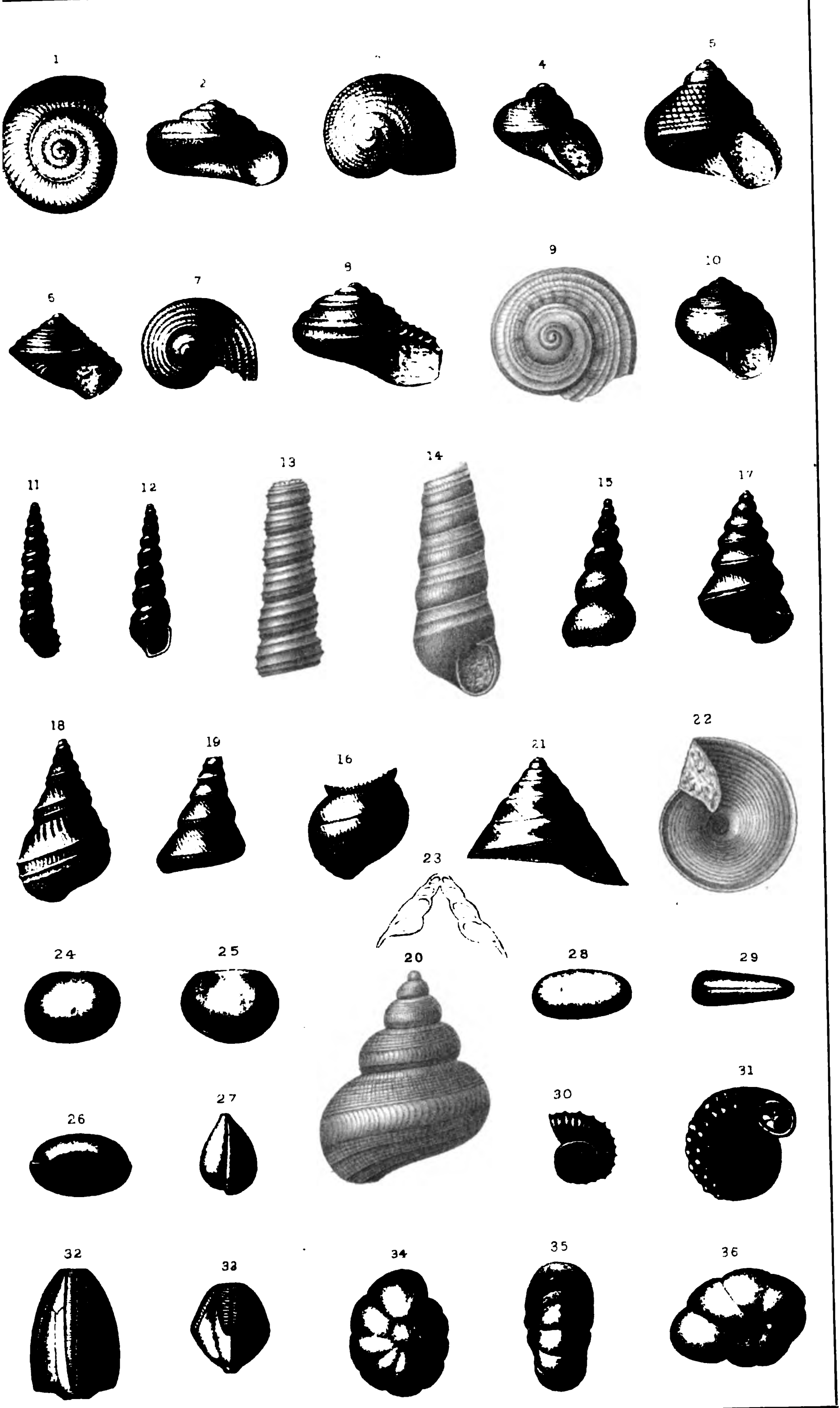
SPERGEN HILL FOSSILS.

(Gasteropoda &c.)



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DESCRIPTION OF PLATES.

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PLATE XI.—FIGURE OF THE SAME, AS IN PLATE X., seen from above.

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Fig. 3. Spiracles, exterior portion.
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Fig. 5. First lumbar vertebra, or the twentieth from the cranium of the same.
Fig. 6. Caudal vertebra of the same.
Fig. 7. Profile of the nasal region of the same.
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PLATE XII.—SKELETON OF THE "NEW YORK WHALE" (*Balæna cisarctica*, Cope).

PLATE XIII.—CRANIUM OF *Balæna cisarctica*, Cope, from a drawing of the "Charleston Whale," by Dr. Manigault.

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EXPLANATION OF PLATE 14.

Lingulepis minima, Whitf. Page 141.

Fig. 1. An enlarged view of a ventral valve.
Fig. 2. A dorsal valve enlarged.

Obolella prima, Conrad's sp. Page 142.

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Orthisina orientalis, Whitf. Page 144.

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Dikellocephalus Marcoui, Whitf. Page 150.

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Arionellus quadrangularis, Whitf. Page 147.

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Fig. 11. Fragment of a cheek, enlarged.
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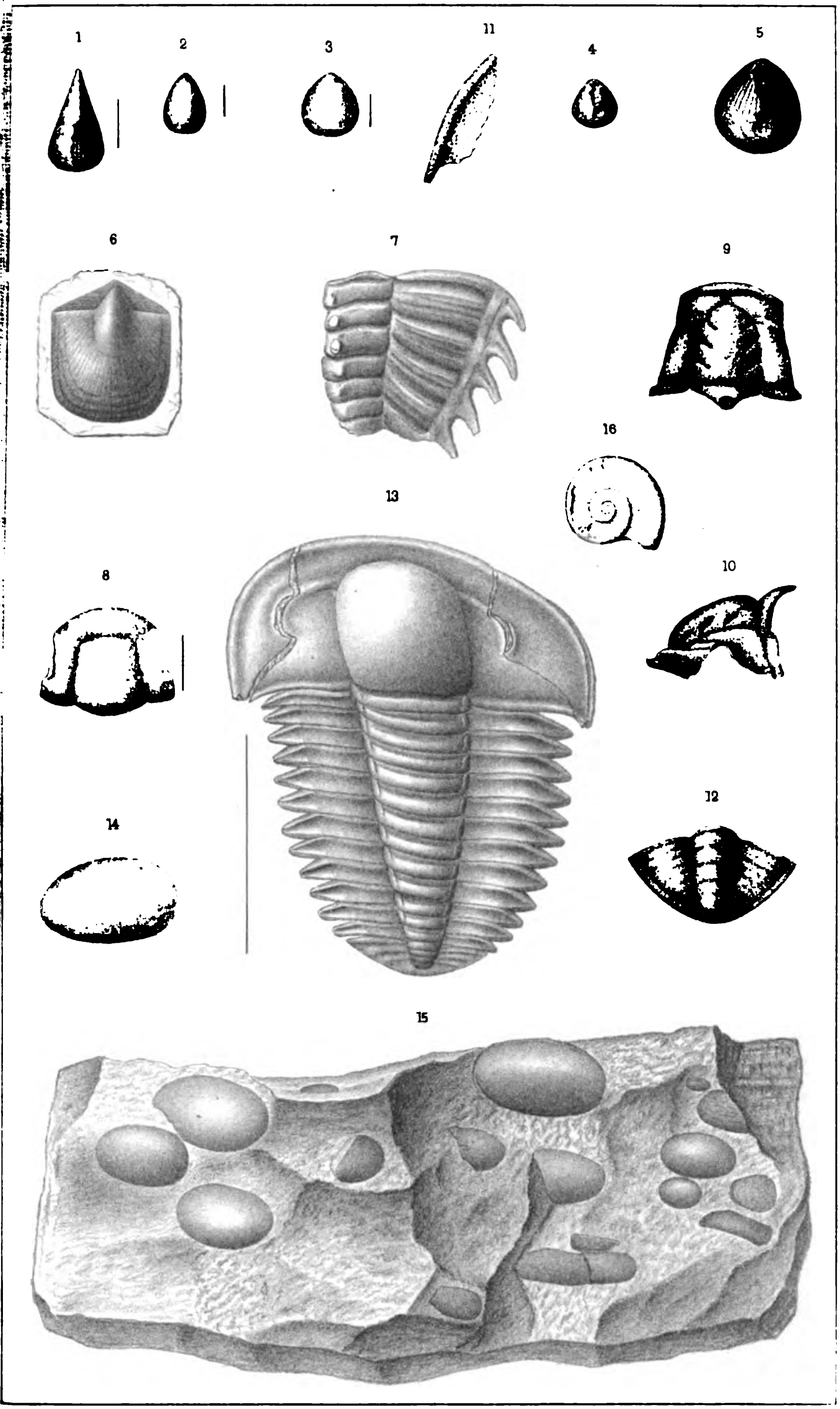
Angelina Hitchcocki, Whitf. Page 148.

Fig. 13. View, twice enlarged, of very complete specimen.

Nothozoe Vermontana, Whitf. Page 144.

Fig. 14. View of a large valve, natural size.
Fig. 15. View of a block of sandstone containing several individuals.



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EXPLANATION OF PLATE 15.

Olenellus Thompsoni, Hall. Page 151.

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Olenellus Vermontana, Hall. Page 152.

Figs. 2–4. View of specimens of this species showing variations in form, as indicated under the remarks on *O. Thompsoni*.

PRIMORDIAL FOSSILS.

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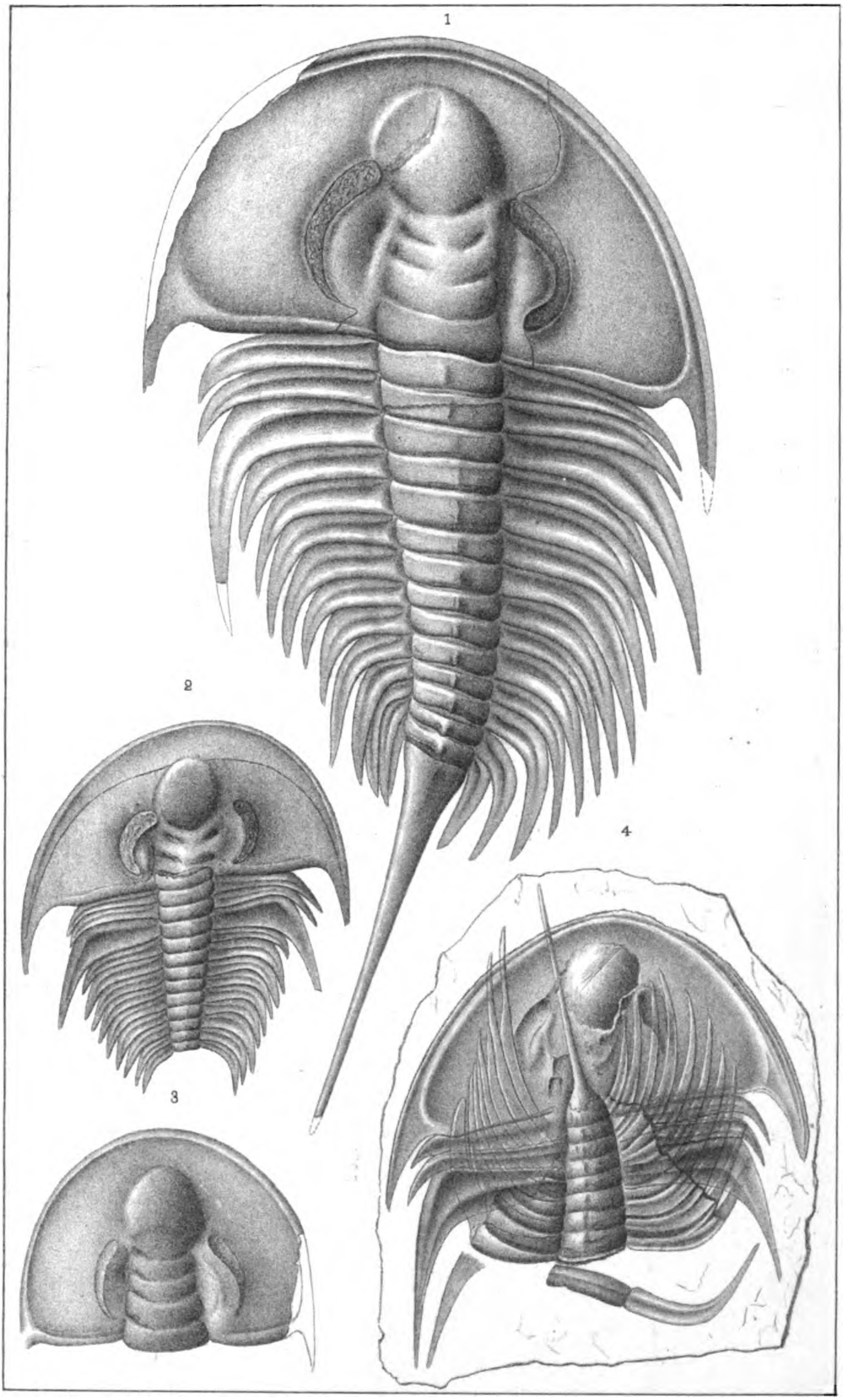

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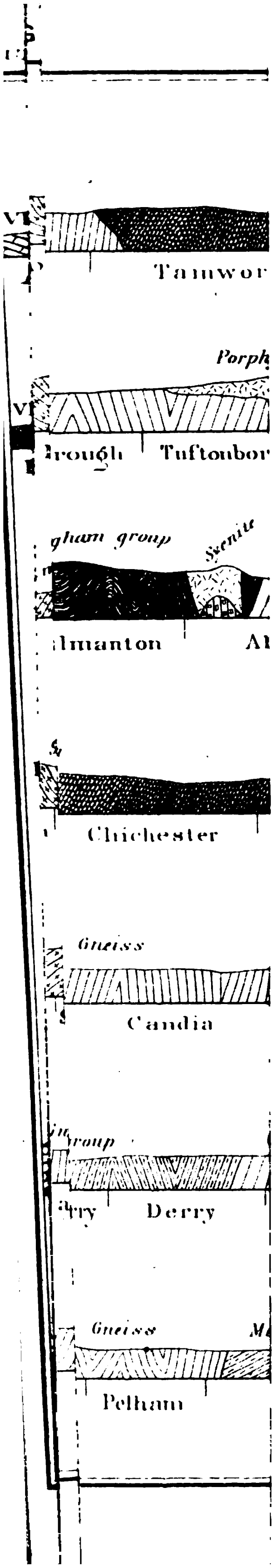
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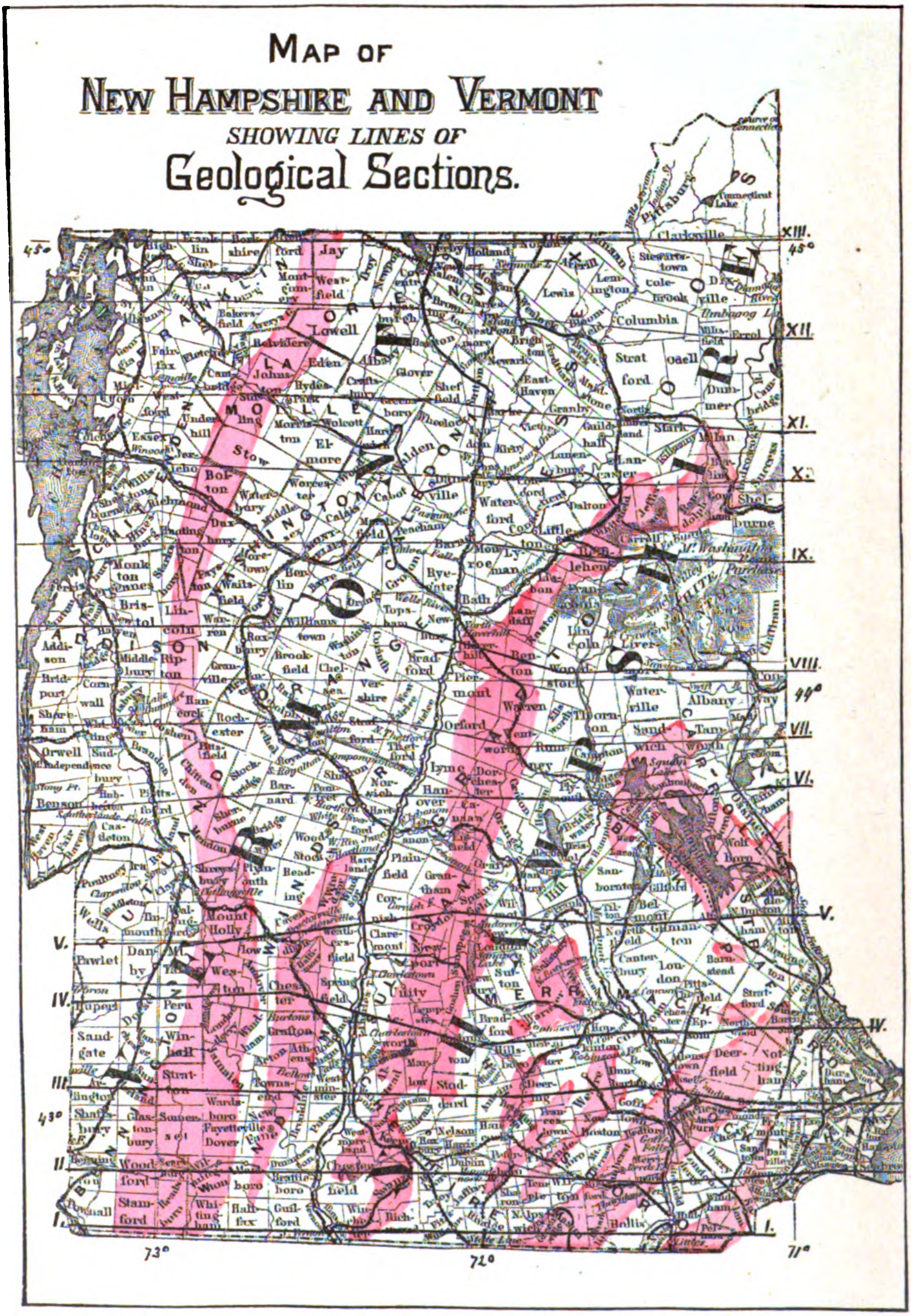
Vol. 1, No. 5. Plate 18.



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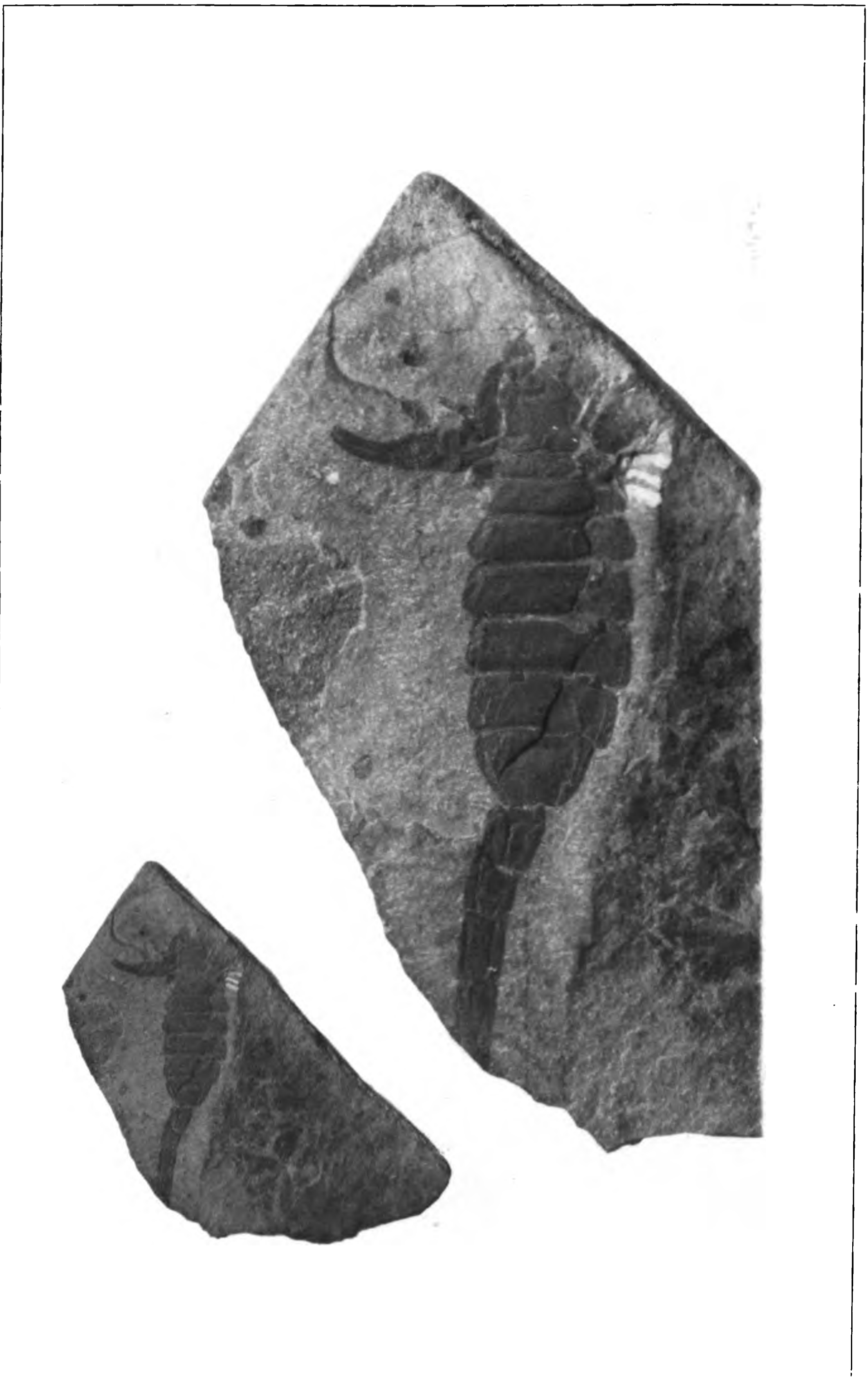

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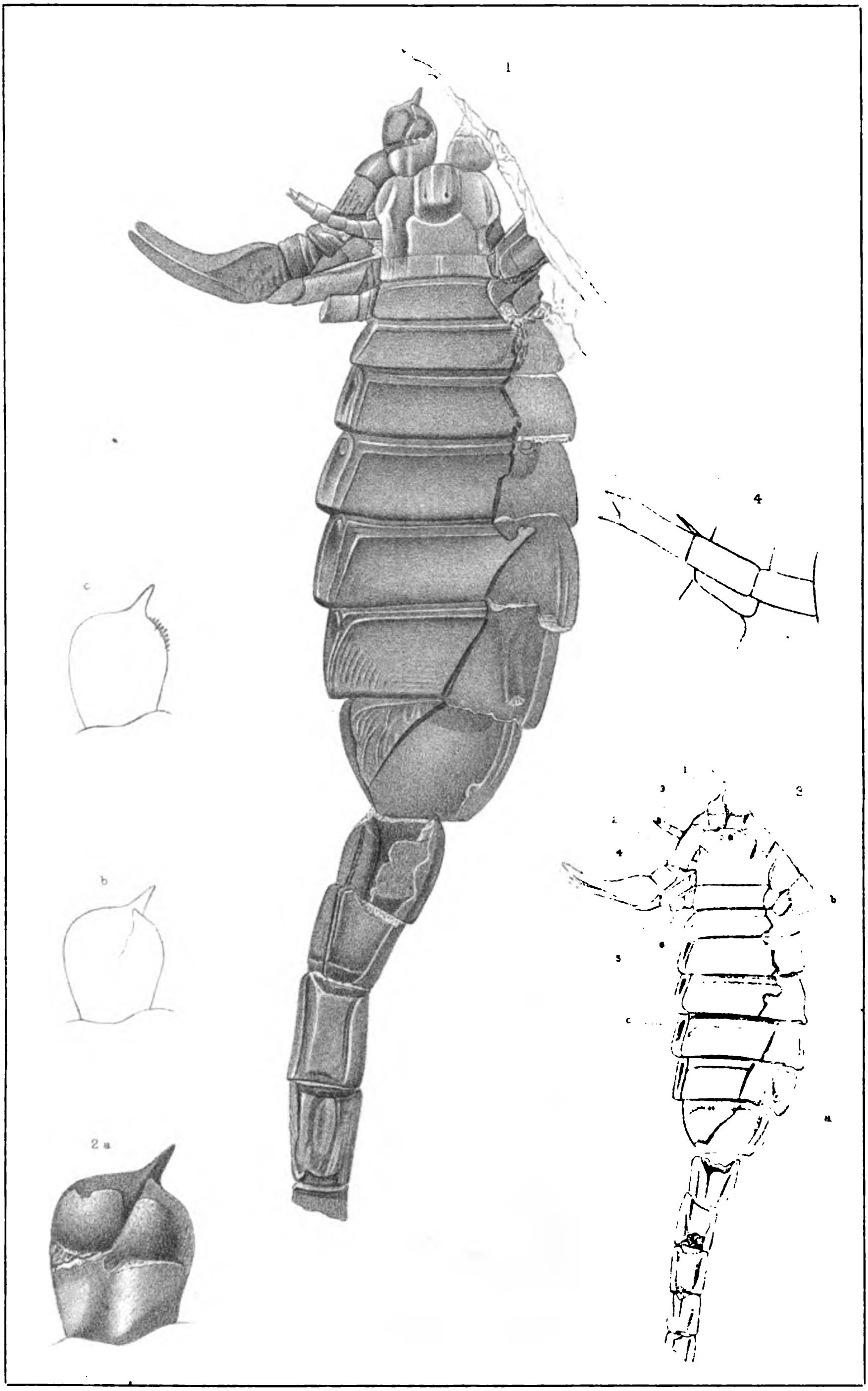

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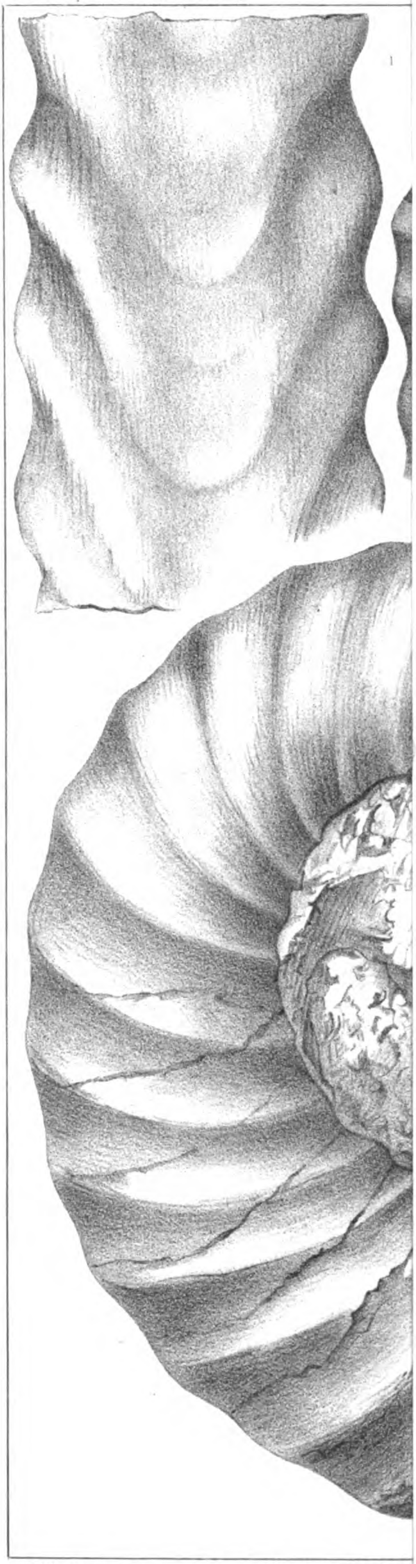

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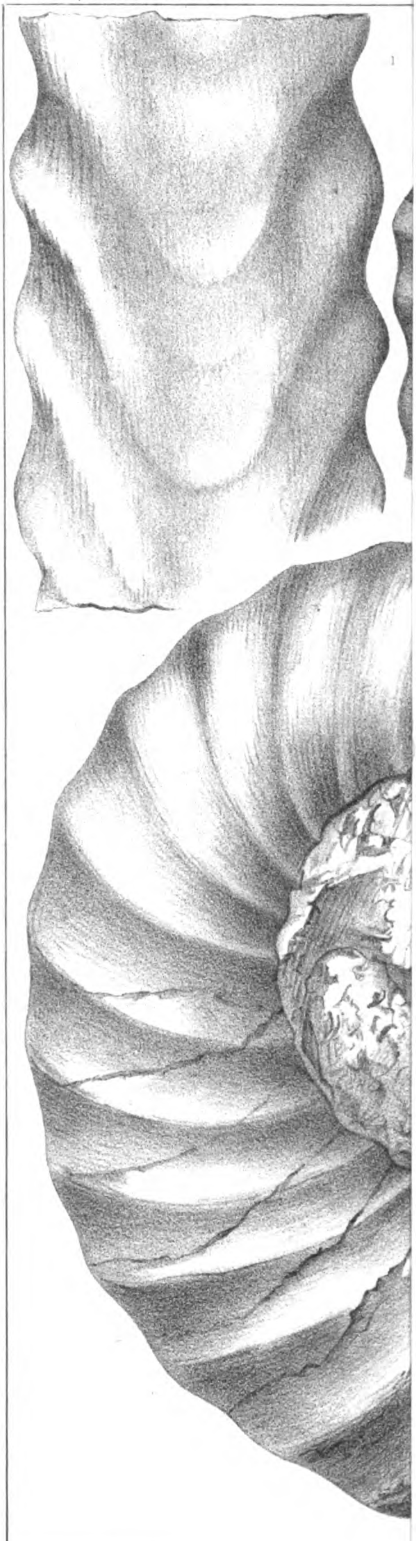

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COLINUS RIDGWAYI. ½ nat. size.

EXPLANATION OF PLATE 24.

Hemipronites apicalis, Billings. Page 300.

Figs. 1 & 2. Dorsal and ventral valves (2x).

Fig. 3. A ventral valve with apex ground off, showing the septa in the interior (3x).

Figs. 4 & 5. Apical and cardinal views of a ventral valve showing the deltidial callus.

Leptæna, sp. Page 302.

Fig. 6. View of a ventral valve, natural size.

Streptorhynchus? primordiale, Whitf. Page 301.

Fig. 7. View of the dorsal valve described (2x).

Orthis Evadne, Billings. Page 300.

Fig. 8. View of a dorsal valve (2x).

Triplesia lateralis, Whitf. Page 303.

Figs. 9–11. View of a dorsal and ventral valve, natural size.

Pleurotomaria? Etna? Billings. Page 316.

Figs. 12 & 13. Lateral and basal views of a specimen referred to this species.

Raphistoma compressum, Whitf. Page 309.

Figs. 14 & 15. Vertical view and outline profile of the type.

Clisospira lirata, Whitf. Page 308.

Figs. 16 & 17. Vertical and lateral views of the specimen (2x).

Euomphalus circumliratus, Whitf. Page 308.

Figs. 18–20. Vertical, basal and lateral views of the partial cast.

Fig. 21. Enlargement of a part of the volution to show the surface striæ.

Murchisonia? prava, Whitf. Page 316.

Fig. 22. View of the back of the specimen described.

Tryblidium ovatum, Whitf. Page 305.

Figs. 23 & 24. Views of a specimen preserving part of the shell, the latter view enlarged twice.

Fig. 25. Vertical view of a second specimen.

Tryblidium conicum, Whitf. Page 306.

Figs. 26 & 27. Lateral and vertical views of a small specimen.

Figs. 32 & 33. Similar view of a still smaller specimen.

Tryblidium simplex, Billings. Page 306.

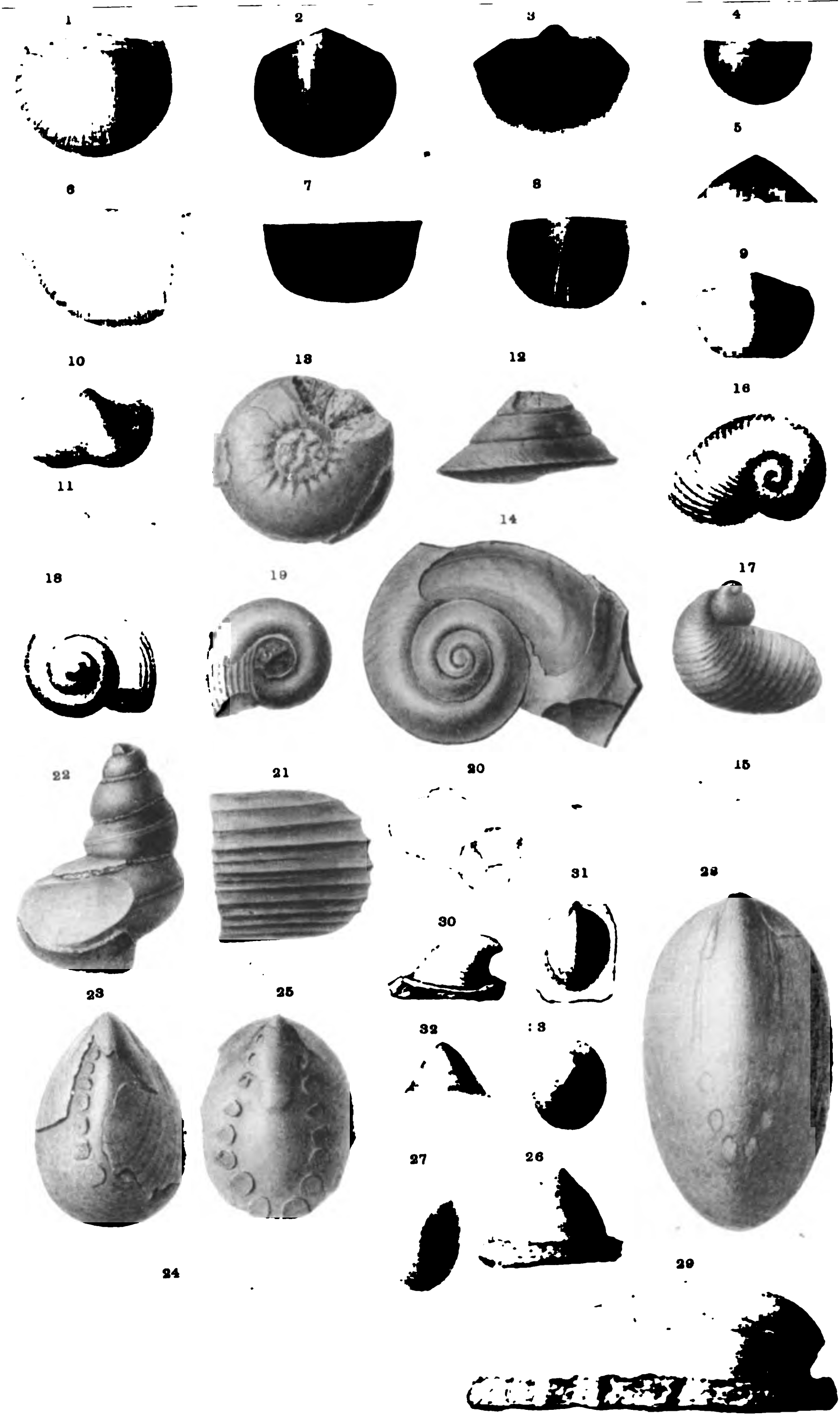
Figs. 30 & 31. Two views of the largest individual of the species observed.

Tryblidium ovale, Whitf. Page 305.

Figs. 28 & 29. Two views of the type, natural size.

FORT CASSIN FOSSILS.

(Brachiopoda and Gasteropoda.)



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EXPLANATION OF PLATE 25.

Lophospira Cassina, Whitf. Page 312.

Figs. 1 & 2. Two views of the largest specimen seen.

Fig. 3. View of a partially grown specimen.

Fig. 4. Front view of an imperfect adult specimen, showing the columellar callosity.

Holopea arenaria, Billings. Page 310.

Fig. 5. View of the specimen identified with this species.

Holopea Cassina, Whitf. Page 310.

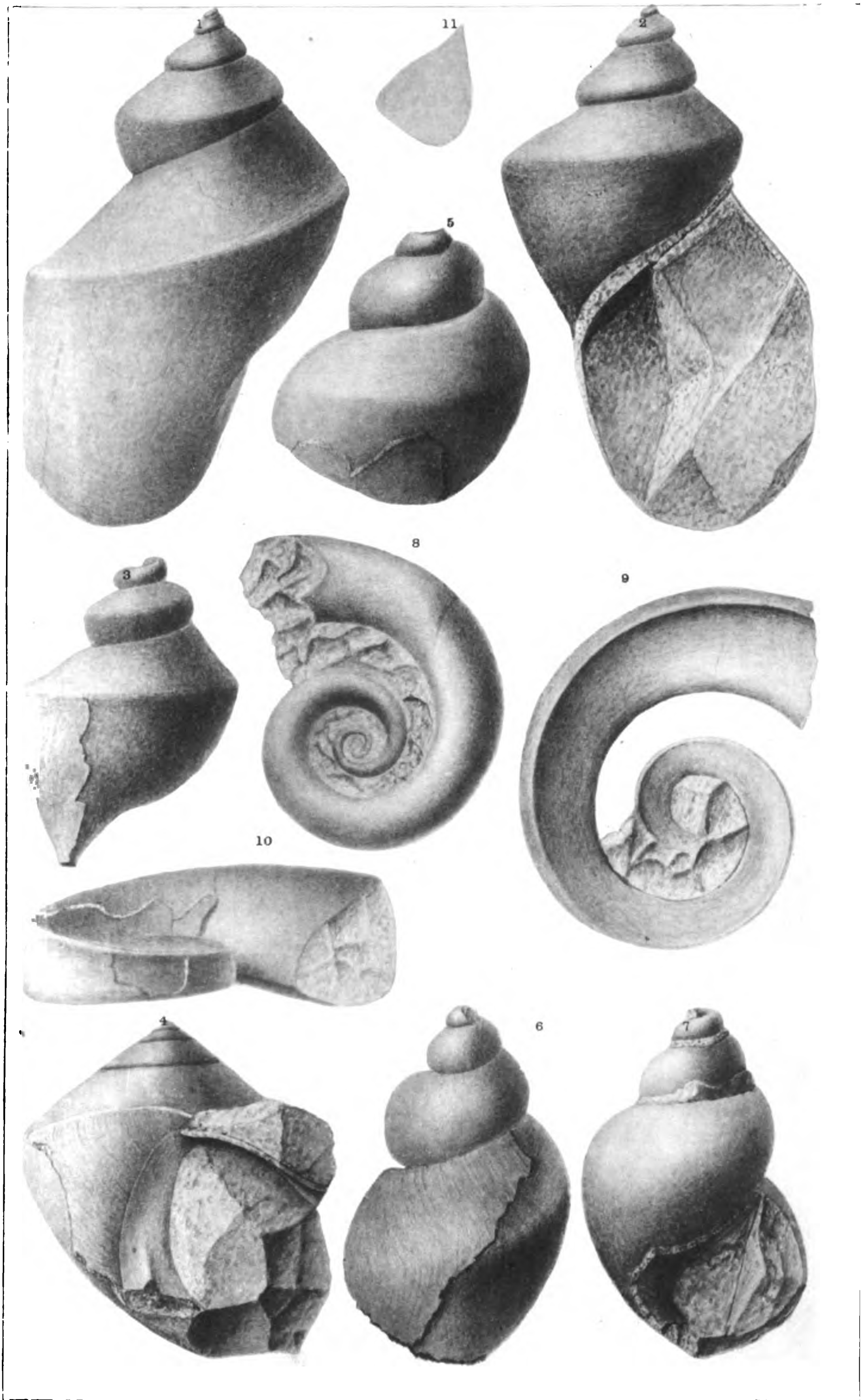
Figs. 6 & 7. Back and front views of a well-formed specimen, showing the surface striæ in part.

Ecculiomphalus volutatus, Whitf. Page 314.

Fig. 8. View of the under side of a partial cast.

Figs. 9 & 10. Upper and lateral views of another specimen.

Fig. 11. Diagram showing the form of a section of the tube.



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EXPLANATION OF PLATE 26.

Calaurops lituiformis, Whitf. Page 315.

Fig. 1. View of a specimen showing the under side, the inner coils being filled with a deposit of lime. The shaded diagram gives the section of the inside at *a*.

Fig. 2. View of one showing the upper surface, the inner coils preserved. The diagram shows the form of a section at *b*, the flattened side being the top.

Fig. 3. Outline profile foreshortened.

Fig. 4. A fragment of the shell from the straight part of another specimen.

Murchisonia (Fusispira) obelisca, Whitf. Page 317.

Figs. 5 & 6. Two views of the most entire specimen collected.

Subulites obesus, Whitf. Page 318.

Fig. 7. View of the specimen described, the anterior part imperfect.

Bellerophon Cassinensis, Whitf. Page 318.

Figs. 8 & 9. Lateral and front views of a nearly entire specimen.

FORT CASSIN FOSSILS.

(Gasteropoda.

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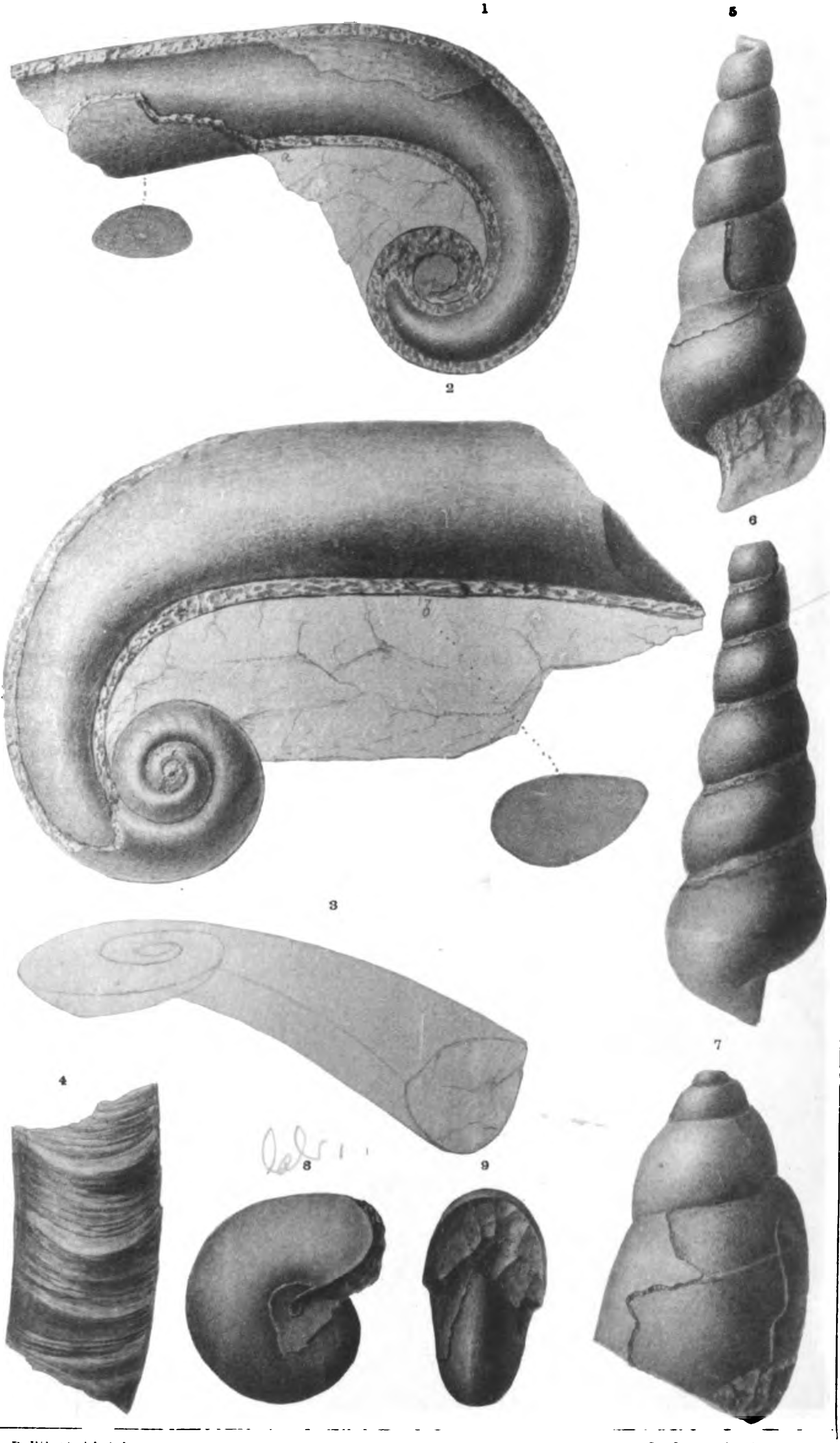

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EXPLANATION OF PLATE 27.

Othoceras cornu-oryx, Whitf. Page 320.

Figs. 1 & 2. Views of two different specimens, showing the prevailing features.

Fig. 6. Section of the septate part of one, showing the septa and siphon.

Gomphoceras minimum, Whitf. Page 321.

Fig. 3. Restored figure of the specimen comprised in figures 4 and 5.

Cyrtoceras confertissimum, Whitf. Page 327.

Figs. 7 & 8. Dorsal and lateral views of a specimen.

Fig. 9. Diagram showing form of the section and position of the siphon.

Cyrtoceras acinacellum, Whitf. Page 327.

Figs. 10 & 11. Lateral and dorsal views of the specimen, natural size.

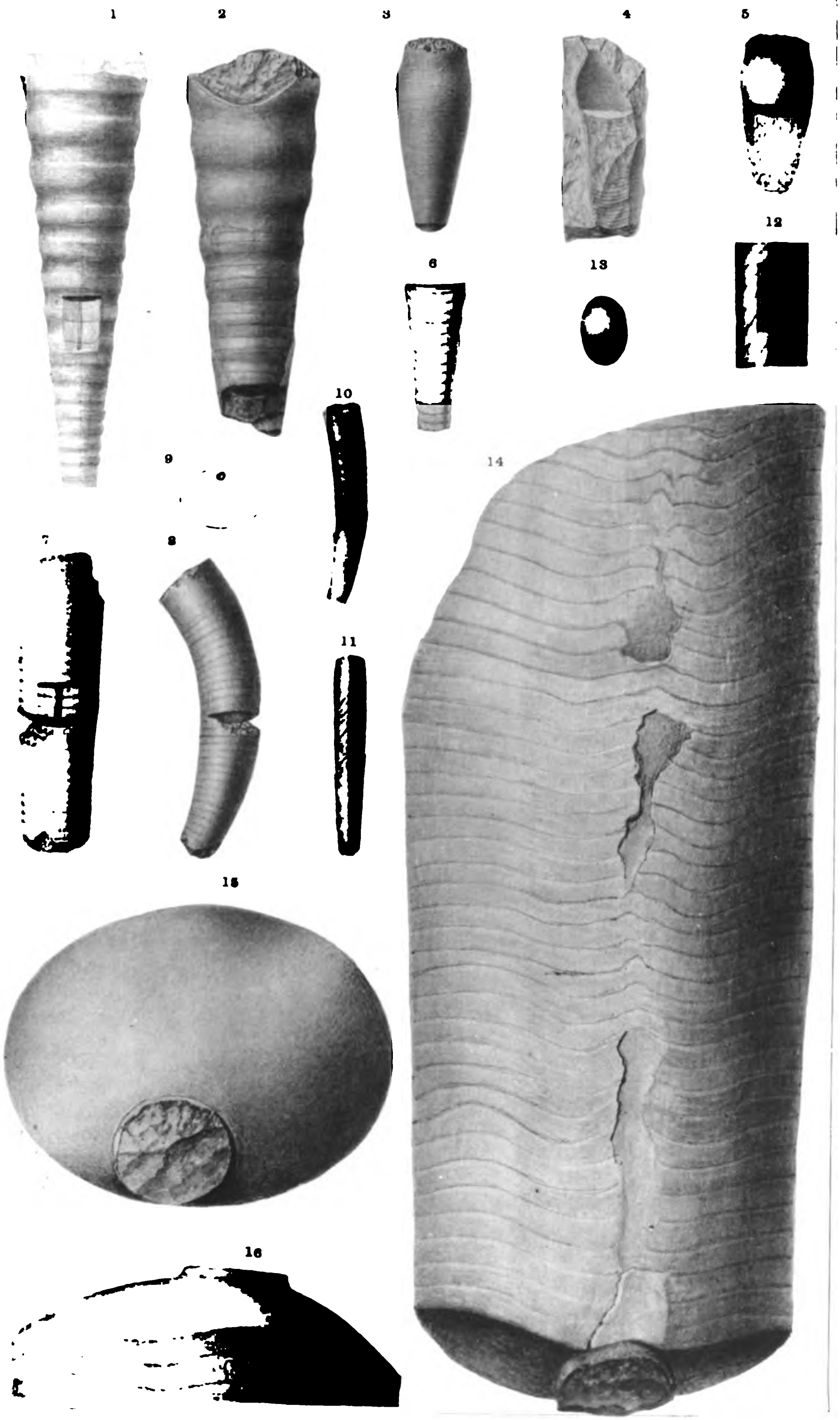
Fig. 12. Enlargement of a part of the back, ground to show the siphon.

Fig. 13. Enlargement of a septum showing its convexity.

Orthoceras Brainerdi, Whitf. Page 319.

Fig. 14. View of the siphonal side of a fragment showing the undulations of the septa.

Figs. 15 & 16. Two views of the end, showing the siphon and convexity of the septum.



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EXPLANATION OF PLATE 28.

Piloceras explanator, Whitf. Page 323.

Fig. 1. Side view of the lower end of a large specimen, which has the siphon protruding below the broken septa. The upper portion above that figured, has five other chambers besides the outer chamber. The specimen is about eight inches long above the projecting siphon.

Fig. 2. View of a longitudinal section of a specimen showing the septa. *a a* indicates the solid part of the siphon, and *b* the cavity of the siphon filled by foreign matter.

Figs. 3 & 4. Two views of a large siphon which has been broken open lengthwise. In fig. 3, *a* indicates the siphonal cavity; *d*, solid matter filling it; a^1, a layer of deposit which separates from those below it; *b*, several thinner layers of deposit, but not septa or proper divisions, such as those described by Salter; *c*, a faulted or disturbed layer of the deposit which appears to have been interrupted in its growth.

Lituites Eatoni, Whitf. Page 331.

Fig. 5. View of a fragment of a specimen of the species showing the septa.

Fig. 6. View of the upper end of the same, showing the form of the transverse section.

Fig. 7. Section through the center of the nucleus of a specimen showing the position of siphon and original septa and nucleus (3x).

FORT CASSIN FOSSILS.

(Cephalopoda.)

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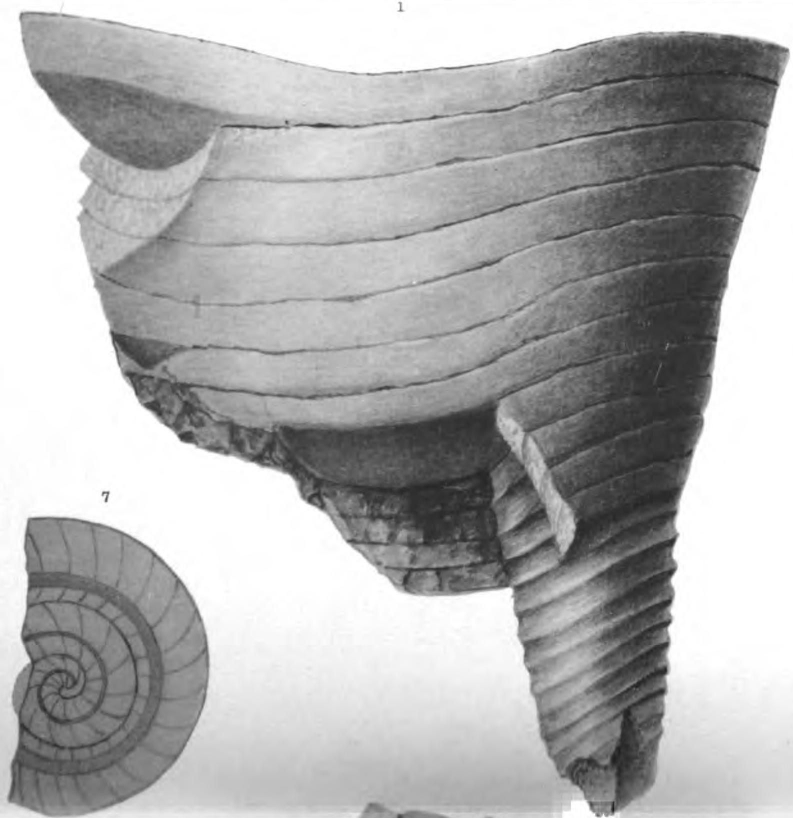

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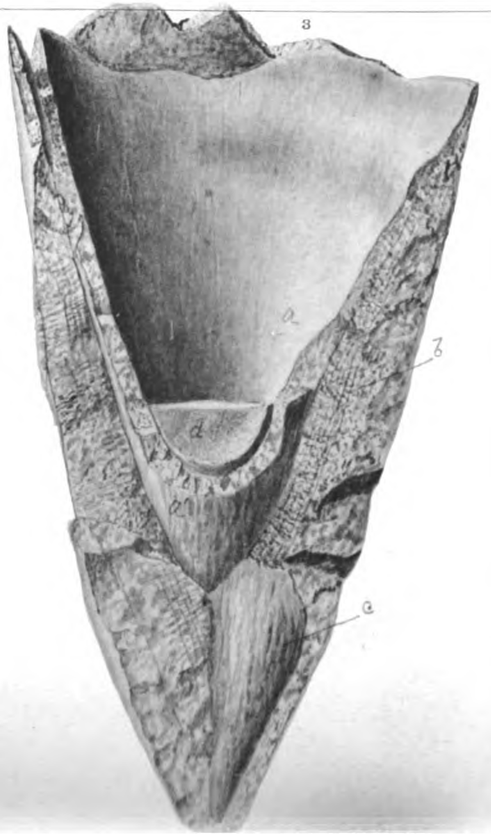

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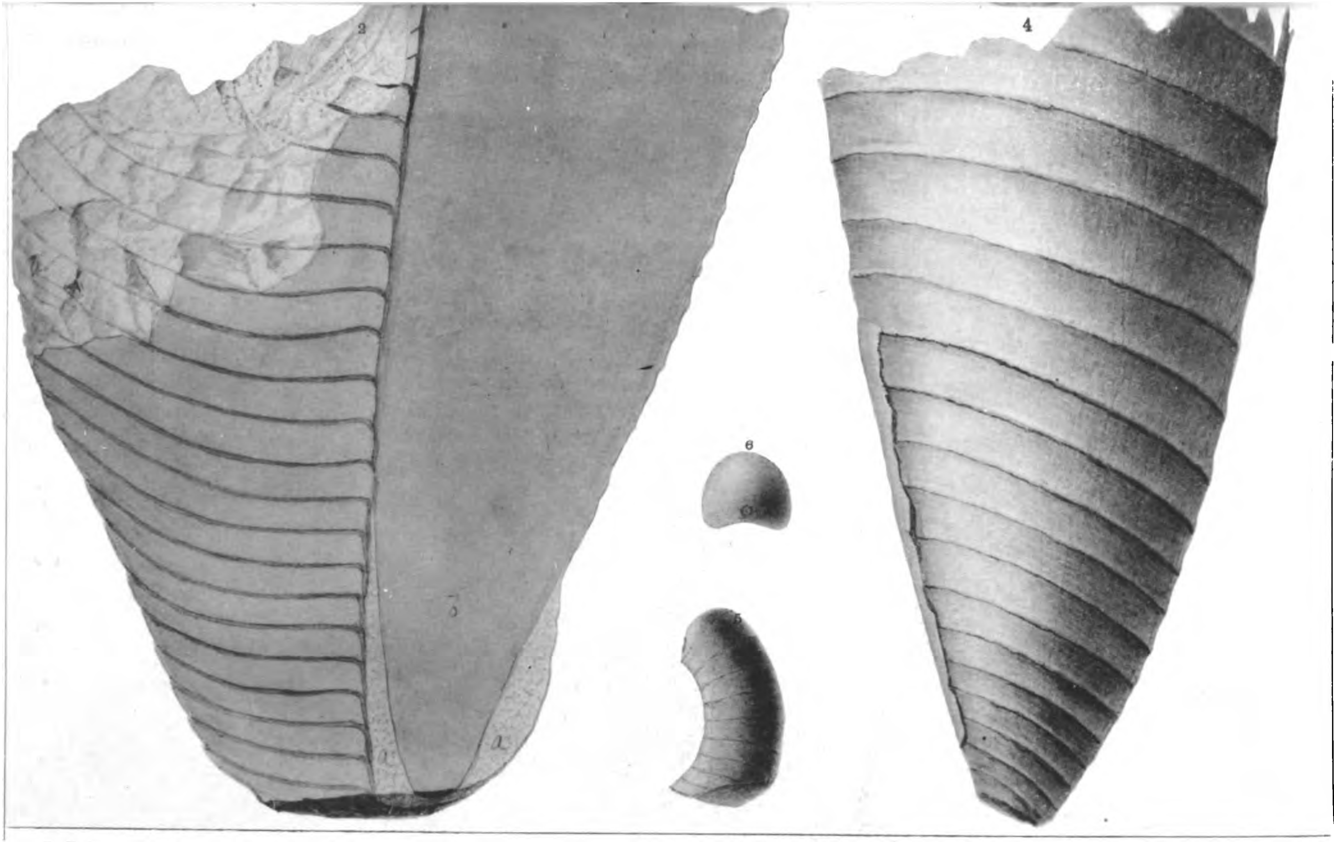

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EXPLANATION OF PLATE 29.

Gomphoceras Cassinense, Whitf. Page 322.

Figs. 1 & 2. Two views of a specimen showing the outer chamber and much of the septate portion. Part of the side is cut away in fig. 2 to show the siphon.

Fig. 3. View of a second specimen with four of the lower chambers, showing the convexity of the lower septum.

Cyrtoceras Boycii, Whitf. Page 326.

Fig. 4. View of the specimen described, which is a longitudinal section cut obliquely through, and imperfect at the lower end. The large beaded siphon is seen to be nearly central.

Lituites internastriata, Whitf. Page 332.

Fig. 5. Lateral view of a specimen retaining much of the shell showing the surface markings.

Fig. 6. Section (2x) through the centre of the inner coils, showing the septa, size and position of the siphon, and the nucleal septa.

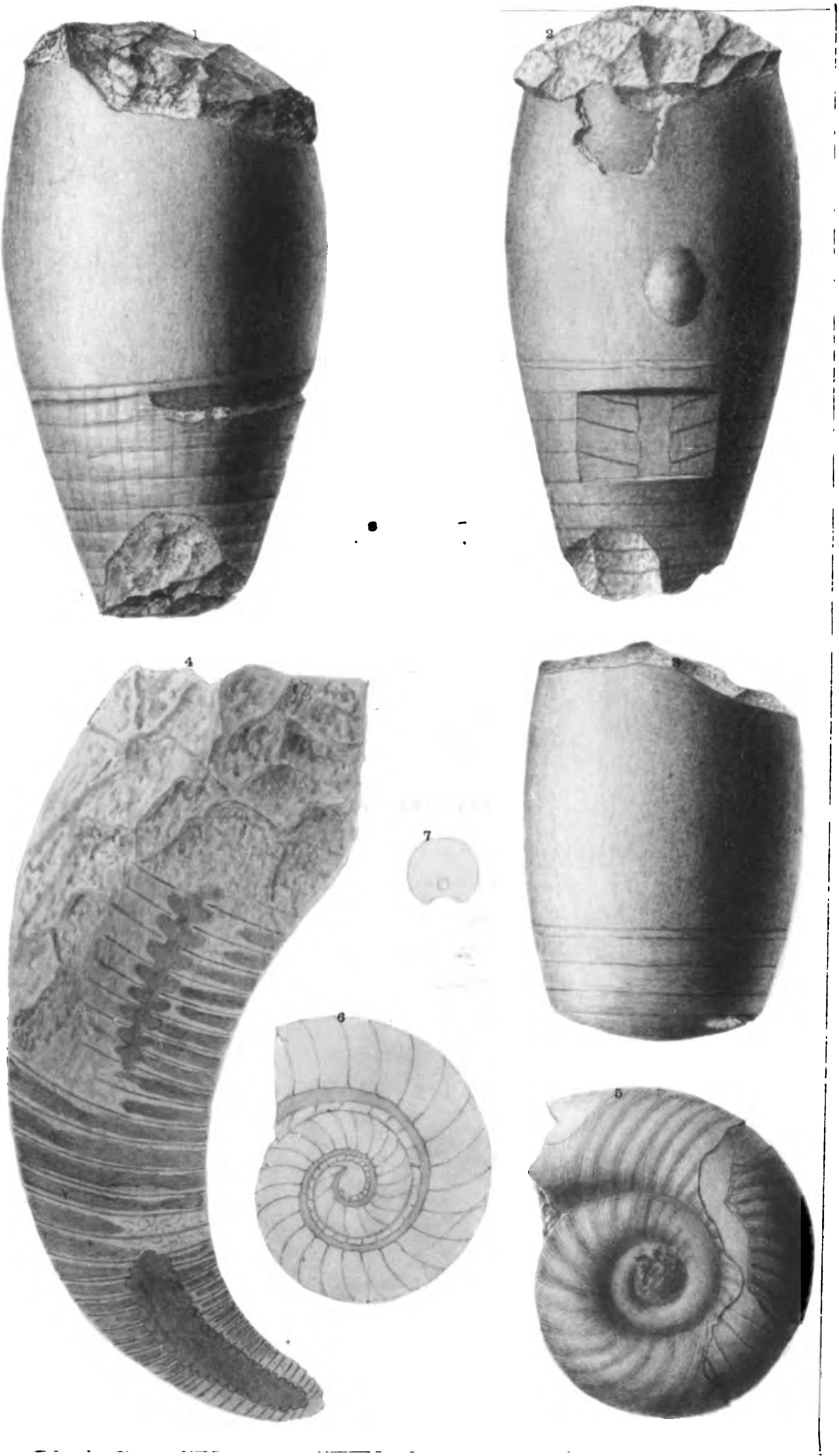
Fig. 7. Diagram of a section of the tube.

Fig. 8. Enlargement of the striæ seen on the internal cast where not abraded or weathered.

FORT CASSIN FOSSILS.

(Cephalopoda.)

Bulletin A. M. N. H. No. 8 | Vol. I. Plate XXIX.



L. P. Gratacap, del. | E. Bierstadt Artotype.

EXPLANATION OF PLATE 30.

Nautilus Kelloggi, Whitf. Page 328.

Fig. 1. Lateral view of the type specimen, showing the features of the species.

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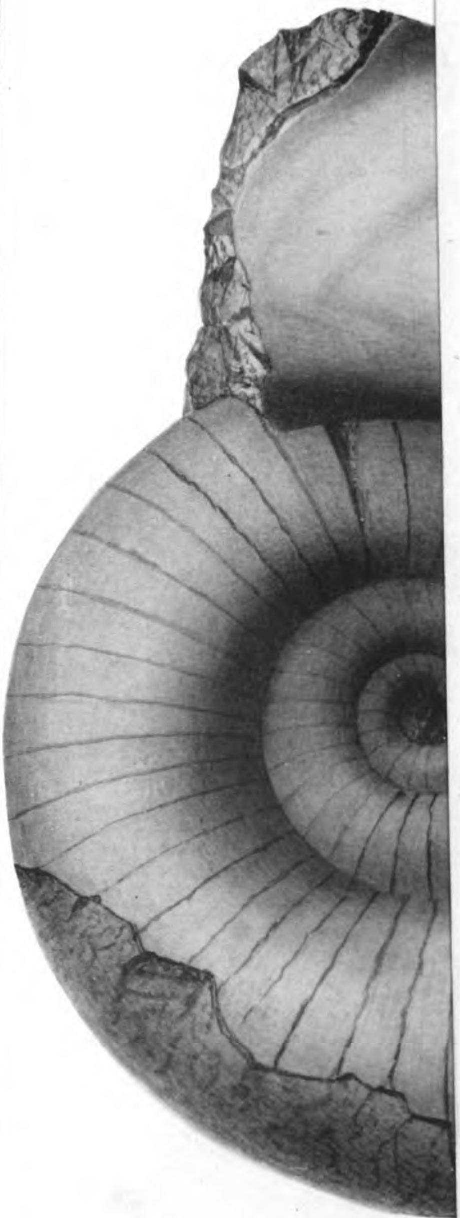

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EXPLANATION OF PLATE 31.

Nautilus? Champlainensis, Whitf. Page 329.

Fig. 1. Lateral view of a specimen showing the expansion of the aperture, the septa and general form.

Fig. 3. View of a section of the back of the outer volution of another specimen.

Lituites Seelyi, Whitf. Page 330.

Fig. 2. View of a section through the middle of a specimen showing the septa and siphon.

Nautilus Kelloggi, Whitf. Page 328.

Fig. 4. View of a young specimen; on a part of the inner coil the shell is preserved, showing surface striæ.

Fig. 5. A section through a fragment, showing the position of the siphon.

FORT CASSIN FOSSILS.

(Cephalopoda.)

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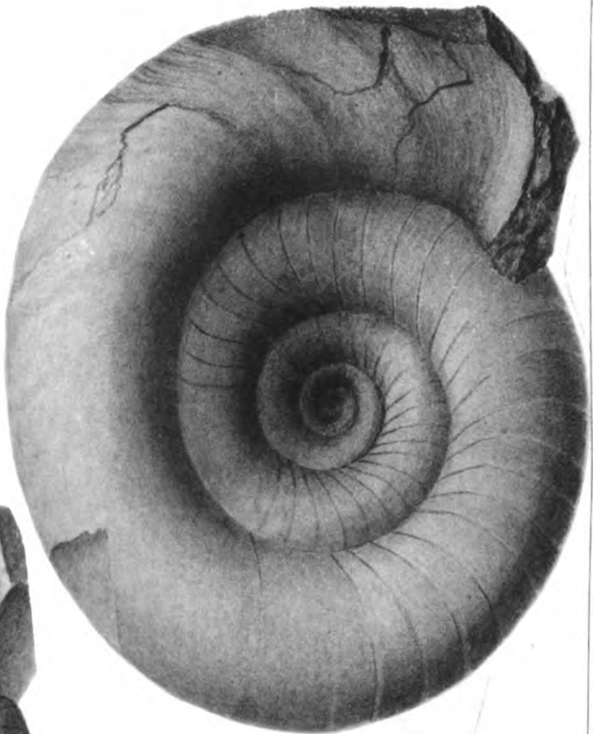

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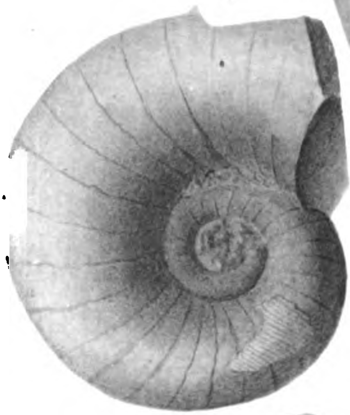

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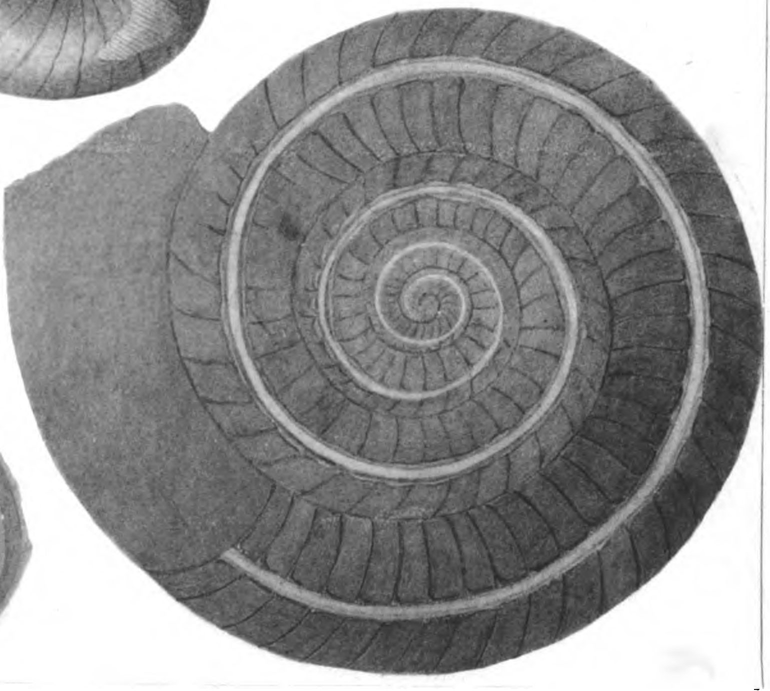

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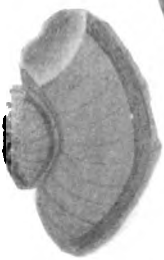

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EXPLANATION OF PLATE 32.

Lituites Eatoni, Whitf. Page 331.

Fig. 1. Lateral view of the specimen first described, showing the outer chamber deflected.

Lituites Eatoni var. **Casinensis** Whitf. Page 332.

Fig. 2. Lateral view of the specimen, showing the round volutions and regular striæ.

Lituites Seelyi, Whitf. Page 330.

Fig. 3. Lateral view of a large individual, which retains the shell over a large part of the surface.

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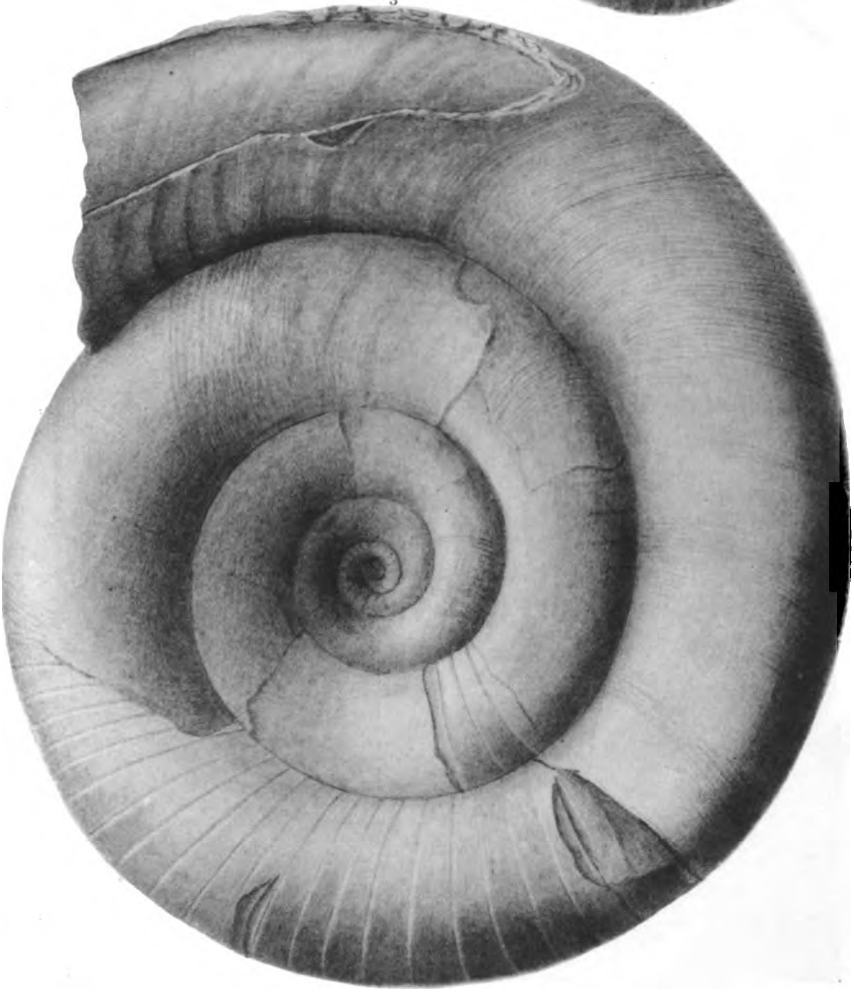

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EXPLANATION OF PLATE 33.

Ribeiria ventricosa, Whitf. Page 344.

Figs. 1 & 2. Lateral and dorsal views of a cast, enlarged two diameters, showing the general form and muscular markings.

Ribeiria compressa, Whitf. Page 344.

Fig. 3. Lateral view of the cast, natural size.

Figs. 4 & 5. Dorsal and lateral diagramic views of the specimen, enlarged.

Lichas Champlainensis, Whitf. Page 342.

Figs. 6 & 7. Vertical view and outline profile of the specimen described.

Fig. 8. Enlargement of the surface.

Sao? Lamottensis, Whitf. Page 334.

Fig. 9. Enlarged view of the glabella and fixed cheeks, showing the general form and surface markings.

Fig. 10. Outline profile of the same.

Fig. 11. Enlarged view of a thorax.

Bathyurus Seelyi, Whitf. Page 339.

Figs. 12 & 13. Vertical and profile views of the best preserved head, the glabella somewhat compressed.

Fig. 14. Outline of a glabella retaining its entire convexity.

Fig. 15. View of a movable cheek supposed to be of the same species.

Fig. 16. Restored pygidium, made from two individuals; one of this size, the other somewhat smaller.

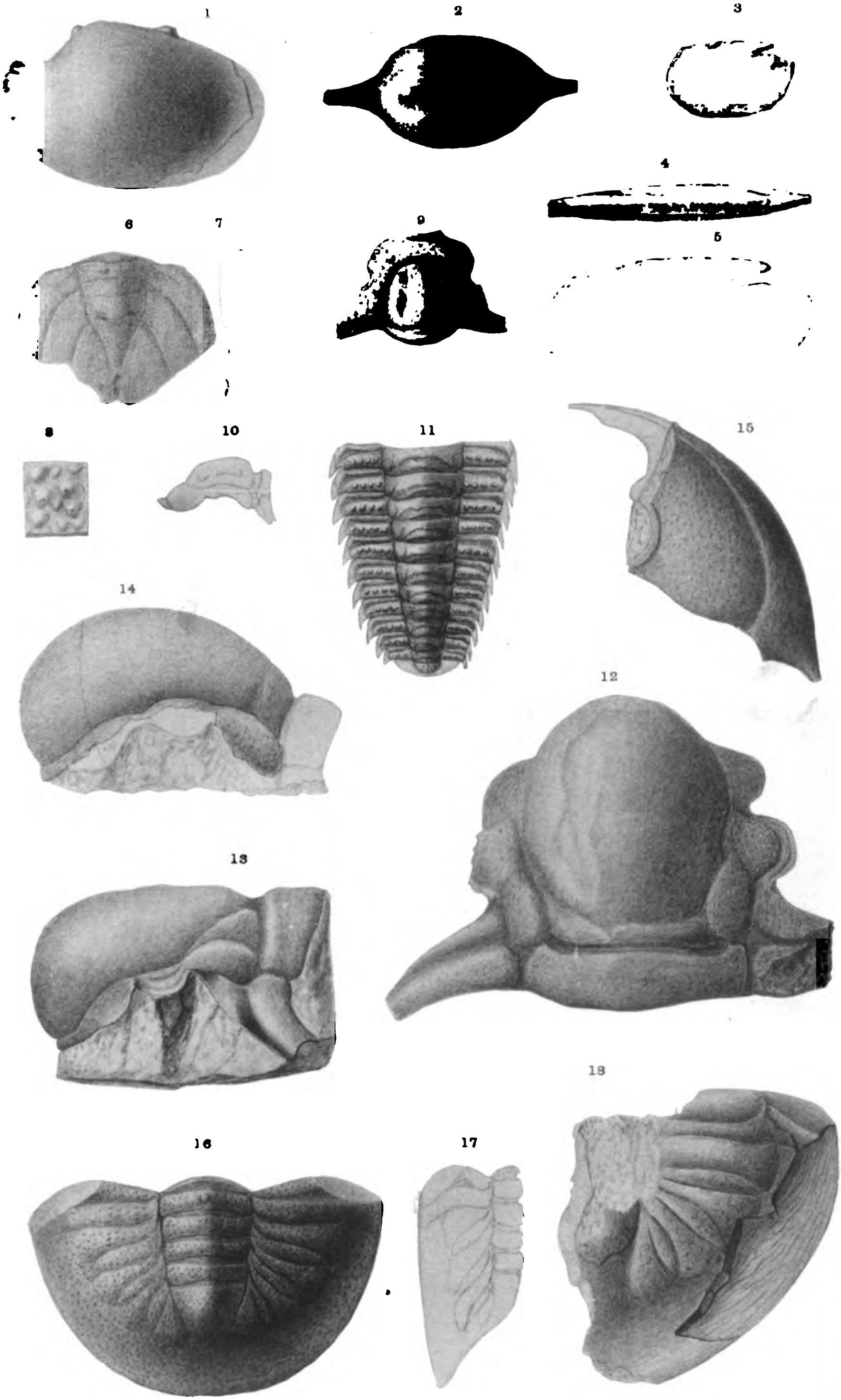
Fig. 17. Outline profile from the same source.

Fig. 18. Fragment of a larger pygidium. The flat under plate is seen on the right margin.

FORT CASSIN FOSSILS.

(Crustacea.)

Bulletin A. M. N. H. No. 8 Vol. I. Plate XXXIII.



R. P. Whitfield del. E. Bierstadt Artotype

EXPLANATION OF PLATE 34.

Asaphus canalis, Con., in MS. Page 336.

Fig. 1. View of a small glabella and fixed cheeks, showing the quadrangular form.

Figs. 2 & 3. Views of two imperfect glabellas, showing portions of the suture line.

Fig. 4. View of a small imperfect movable cheek.

Fig. 5. Part of a large movable cheek.

Fig. 6. An imperfect hypostoma as obtained from a gutta-percha impression in the matrix.

Fig. 7. View of a medium sized pygidium.

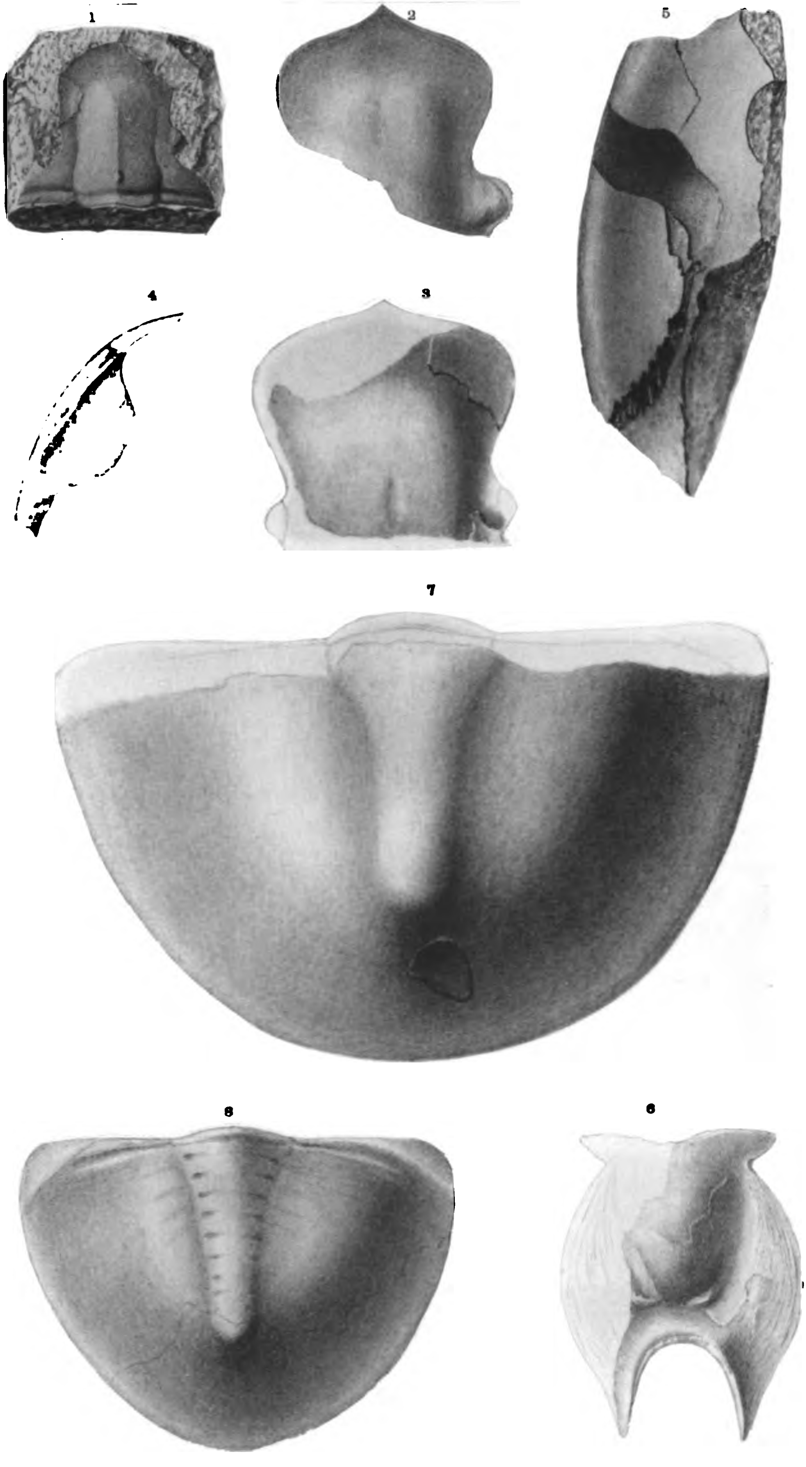
Fig. 8. A smaller pygidium which shows the annulations.

FORT CASSIN FOSSILS.

(Crustacea.)

Bulletin A. M. N. H. No. 8

Vol. I. Plate XXXIV



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EXPLANATION OF PLATE 35.

Rhombodictyon discum, Whitf. Page 348.

Fig. 1. View of the specimen, natural size.

Rhombodictyon reniforme, Whitf. Page 347.

Fig. 2. View of a small specimen, apparently double.

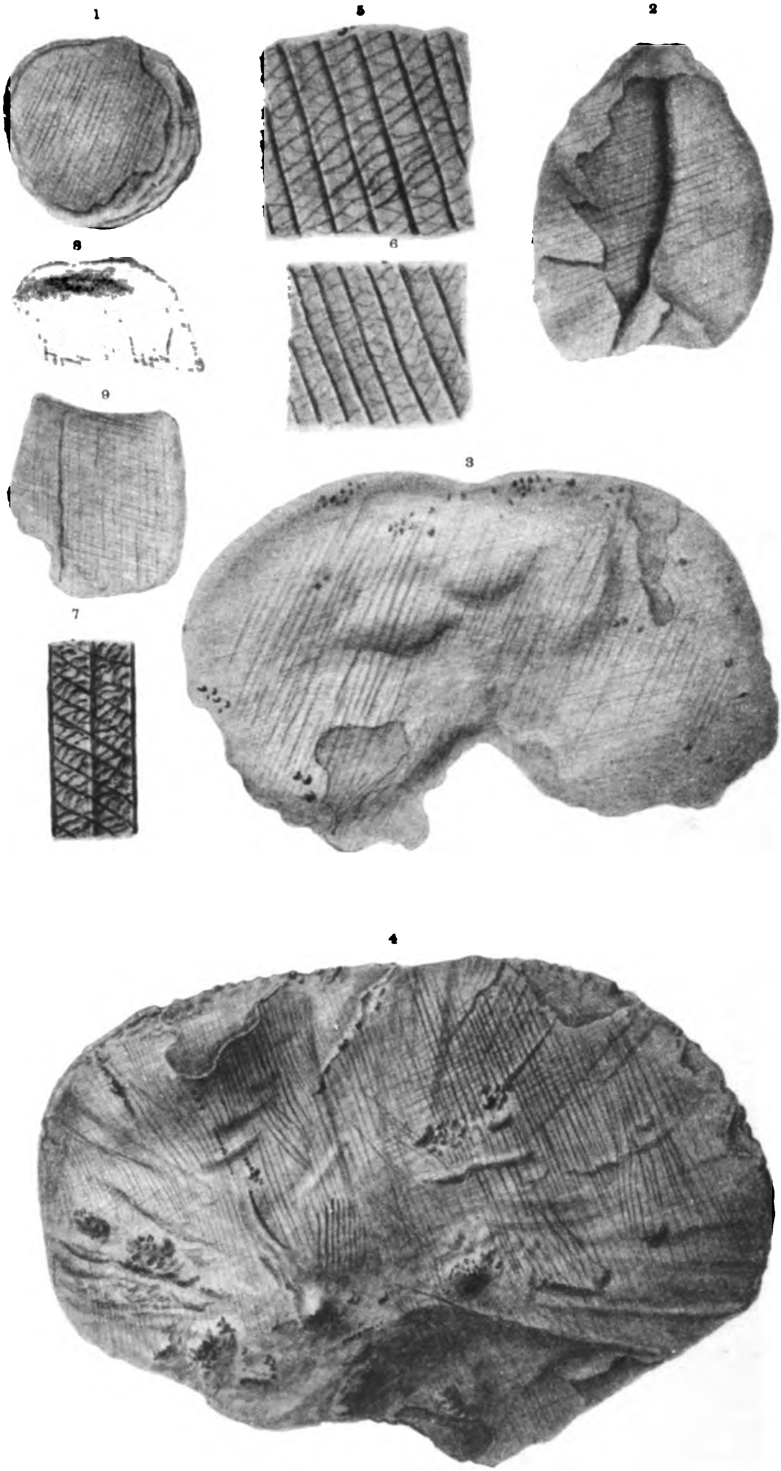
Fig. 3. View of a medium sized, very perfect specimen.

Fig. 4. View of the largest and most perfect specimen yet seen.

Figs. 5–7. Enlargement to show the different appearances presented in different lights.

Rhombodictyon reniforme var. **rhombiforme**, Whitf.
Page 348.

Figs. 8 & 9. View of two different specimens presenting the features described.



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DECEMBER 23d, 1881.

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SEPTEMBER 20th, 1882.

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OCTOBER 20th, 1882.

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(1.) The exterior characters and osteology of a cisarctic Right Whale—male.

(2.) The exterior characters of a cisarctic Right Whale—female.

(3.) The osteology of a cisarctic Right Whale—sex not known.

To which is added a concise résumé of historical mention relating to the present and allied species.

By JOSEPH BASSETT HOLDER.

MAY 1st, 1883.

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